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Television: The Technology that changed our lives
Subset: Color
SS: CBS color
(260403)

(Author's tracking notes: Tracing the historical development of color TV in America has been an interesting challenge. There has been no shortage of "headline" material pried from old, yellowed pages of Radio Craft / Radio Electronics, Radio TV News, Televiser and many other periodicals (including Broadcasting). What has been more challenging to run down has been the nitty- gritty first-person detail that went with the early color experiments. I am indebted primarily to a number of engineers and managers who actually worked on the commercialisation of the CBS color project and the time they willingly spent with me and my wife Gay in testing my "theories" of how CBS commercially mismanaged their entry into the color TV world. What follows is a "work in progress" updated as new information comes to the surface and can be verified. Additional efforts are ongoing and will continue until a natural culmination of the subject matter results.)
References to date:
RADIO NEWS (1936 - 1954)
RADIO CRAFT / RADIO ELECTRONICS (as renamed in 1948; 1936 - 1954)
TELEVISER - Journal of Television (1945 - 1951)
FM (later FM & TV; 1941 - 1948)
BASIC TELEVISION (Bernard Grob/ RCA / McGraw Hill 1949)
PRINCIPLES OF TELEVISION ENGINEERING (D. Fink/McGraw Hill 1947, 1951 and prior)
DuMont Anthology: A Historical Study of the DuMont Television Network
Behind The Tube (Andrew Inglis, ex-RCA, 1990)
Wisdom of Sarnoff and RCA (Wisdom Society, 1967)
David Sarnoff (Eugene Lyons, 1966)
AND PART OF WHICH I WAS (George H. Brown, 1982 revised edition)
Maverick Inventor: my turbulent years at CBS (Peter C. Goldmark and Lee Edson; 1973)
And the first person remembrances of Sava Jacobson, Morris L. Tucci, George DeRado and others who's quotations appear here.

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Scenario:
a) In November 1940 the status of American television was:
1) Approximately ten low-band (44 - 68 Mc/s) experimental stations were capable of tests. Most operated with test pattern and some broadcast an occasional film. RCA's W2XBS (44 - 50 MHz) and Los Angeles W6XAQ (50 - 56 Mc/s; Don Lee Radio Network) had been or were maintaining schedules of 1 to 3 hours daily; Sundays excepted.
2) CBS was NOT on the air (November 1940); their Chrysler Building (NYC) transmitter was not yet complete (amongst other problems, they were waiting on RCA to deliver their transmitter!).
3) RCA had come off the (1939) World's Fair TV 'high' having created considerable consumer interest in television becoming an early addition to the American home scene. But following the World's Fair period (May 1939 launch) their experimental programming schedule on W2XBS had dropped off significantly; during September-October (1940) almost no programming was transmitted although they did create a special "Election Night" coverage report during the November 1940 national elections, and then returned to test pattern.

W6XAO 45.0 V 1 KW
5139 49.75 A 300 Gauss
24 FPS

START Dec 03, 1931 UHF

4) Estimations ran from 2,000 (low end) to 4,000 (top end) TV receivers in public hands, mostly in the new York City area. RCA had manufactured the bulk of these followed by GE and Andrea (which sold small 3" screen partially assembled kits to experimenters).

5) TV receivers at that point in time were designed for the 343 line RMA (Radio Manufacturer's Association RCA sponsored) "standard." The audio was AM rather than FM and a high percentage of the sets sold were created in two separate segments; one for video and one for audio (many kits were video only and even GE produced consumer video only sets).

6) The FCC was still studying TV 'standards' with an announced intention of adopting final technical rules preparatory to authorising commercial TV operation. All stations were licensed as experimental and prohibited from accepting commercial (paid for) messages. The RMA, with FCC urging, had formed the NTSC (National Television Standards Committee) and ultimately at least 140 individuals had 'engineering input' as to how the 'final standards' should be configured.

7) CBS was on record as NOT favoring the commercialization of TV at that time citing a list of reasons (to follow). Virtually every other firm in electronics was in favor of TV being authorized for commercial operation.

Thus late in 1940 it appeared that within the foreseeable months to come, the FCC would finalize standards and commercial TV would be authorized. Into this situation:

Dr Peter C. Goldmark, Chief Engineer for CBS Labs, announced to the press he had devised a "color television system" (RADIO NEWS December 1940 et al). His system was an adaptation of an experimental 1929 system first displayed in public by Dr Herbert E. Ives of Bell Labs and prior to that, created originally by English TV pioneer Baird (1928). The heart of the system was a rapidly spinning disc covered in equal parts (1/3rd each) with tinted segments of red, blue and green plastic.

CBS demonstrated the Goldmark system before a wide variety of groups including (the) NTSC, IRE and FCC. In these demonstrations, CBS raised a number of questions centered around the basic query - "Is it prudent to be adopting standards for black and white television and authorising commercial operation of this 'interim' technology when the CBS Goldmark system is 'just around the corner'?" Goldmark's 1940 laboratory configuration required significantly more bandwidth (16 Mc/s) per (color) TV channel than the NTSC recommended 6 Mc/s for black and white. CBS challenged the industry to decide whether "prematurely adopting a 6 Mc/s channel system was proper when these channels might become obsolete as color was phased in."

This had the potential to derail inauguration of commercial (black and white) TV. The FCC was depending upon the NTSC to solidify the many competing recommended black and white standards and out of this decision process would come - amongst other technical factors - the channel allocations. If channels were to be 16 Mc/s wide each, the low band TV channel region which was the first to be put to use for "commercial TV" would accommodate not more than 2 TV channels of which only one could be assigned to a single market. CBS in response to this certainty suggested that "all TV should be operated in the UHF band where there is room for approximately 26 TV channels - each 16 Mc/s in width." Thus CBS had raised not one but two issues each of which had the capacity to totally halt the authorisation of (black and white) NTSC television; channel bandwidth, and, which portion of the frequency spectrum would be home for TV broadcasting.

In December 1940 CBS stepped up its "Color Now!" campaign by enlisting a number of well known people to "speak out" about the "advantages of color TV over black and white." The list included such luminaries as Charlie Chaplin and each enthusiastically endorsed the

CBS color system as "TV worth waiting for." The CBS public relations department was adept in placing these "news stories" in virtually all major newspaper and magazine publications.

The early Goldmark demonstrations were of questionable proprietary. First, they consisted of film-only pickups; showing motion pictures through the color system. Goldmark was widely quoted in the trade press explaining, "Film pickup is actually more complex than live camera television; I have elected to solve the more difficult problem first." When pressed on this statement by technically competent reporters, he admitted, "I have not yet created a working color TV camera" (1940).

The actual technology employed in the pre-World War Two demonstrations is also in some dispute. Initial showings were at CBS laboratories (New York City) and there is no record indicating CBS had filed for an FCC experimental (UHF) TV license to test the system through the air using the UHF channelling which a 16 Mc/s bandwidth required. Goldmark in "Maverick Inventor" would, 33 years after the period in question, maintain he did over the air testing using the CBS TV W2XAX experimental transmitter (Chrysler Building, NYC). RCA developmental engineer George H. Brown seems to verify this testing by explaining in his own technobiography, "*and a part of which I was*," that, "in 1940 CBS was scanning 343 lines in each frame with 60 complete frames or 120 fields per second." What was happening here was we had Goldmark's "paper design system" which he and CBS argued would have to be at UHF because of the 16 Mc/s bandwidth required, and then Goldmark's actual low definition service using the transmitter facility of W2XAX. There is no suggestion, in the trade press of the time nor in FCC records, that CBS ever transmitted color images using more than 343 lines of resolution prior to the end of World War Two. The effect was an illusion: CBS was demonstrating higher definition images only through a closed loop hard wired system with what amounted to a laboratory curiosity but in their public statements elevating the system to a fully functional, broadcast tested service. This subterfuge was also noted by RCA and other engineers who found many of Goldmark's engineering explanations beyond comprehension. "Maverick Inventor" indicates Goldmark first demonstrated his field sequential color system at the CBS Laboratory in June 1940 to CBS management on a 3 inch screen enhanced with a magnifier placed in front of the screen.

Goldmark in Maverick Inventor partially admits our conclusions here when he explains (in his own defence of people like Brown) why 343 line sequential color was *not* low definition. "Although addition of color theoretically may take away detail from a black-and-white picture, in practice the information in the picture is enhanced because many objects are more recognisable through their color content. Even two objects that are close together, such as an orange flower and a turquoise flower, will tend to fuse in black and white because they appear to the eye in the same shade of grey. In color, on the other hand, they are easily differentiated."

When designing content for demonstrations given to the press, the FCC, members of Congress and influential business people, great care was taken to create images which did just that - appear grey and washed out on the black and white monitor that was ideally placed side by side to the color monitor.

RCA was caught flat-footed by the sudden CBS color announcement and correctly feared that if allowed to go unchallenged could derail nearly ten years of efforts to turn TV into a home product. Their first responses were feeble, defensive, but probably honest:

1/ RCA had also been working on a color system.

2/ The system's status in late 1940 was described as a "laboratory curiosity" which perhaps was a carefully chosen phrase as most industry engineers were using the same phrase, privately, to describe the Goldmark system.

3/ Performance by those outside of RCA who had seen pictures on a screen was described as "poor."

Heading into 1941, Goldmark continued to make demonstrations including an early one for a delegation of FCC Commissioners and engineers (September 4, 1940) who enthused about what they saw. One FCC engineer who had been witness to both the CBS and RCA systems at that stage of evolution told the press, "There is no comparison between the two - CBS is the winner." FCC Chairman Larry Fly did, according to Goldmark, take him aside after the demonstration to offer a suggestion - mandate, actually. "If you wish to pursue this as an option for FCC consideration, we will have to see live camera TV as well using your system."

Meanwhile pressure on the NTSC group and the FCC to settle on "standards" increased and in May 1941 agreement was reached at NTSC. There would be 441 lines of video (coincidentally the same number of lines as the British system), FM sound (a victory for FM promoter Major Armstrong) and 6 Mc/s bandwidth channels. The FCC took these recommendations under study and in June 1941 announced their final standards decision: 525 lines, FM sound. Donald Fink ("*Principals of Television Engineering*," McGraw Hill) would later explain, "Allen B DuMont, who had perhaps the best credentials in the world for the video display portion, was urging 625 lines and FM sound. RCA's W2XBS and Don Lee's W6XAQ programming transmissions had largely been made with 343 lines of video and those (few) who had seen the BBC 441 line images were enthusiastic about the improvement in video definition when a greater bandwidth was employed. The NTSC wrestled between DuMont's 625 lines and RCA's 441 and RCA won."

But the FCC bought some of what DuMont was saying and as Fink would further explain, "525 lines was a compromise made during a series of last minute telephone exchanges between FCC engineers and people such as myself." In fact, although there were some technical reasons for any line standard and many arbitrary line standards would not work properly, it was Fink himself who ultimately resolved the question at the 11th hour with the 525 line number.

The FCC also established July 1, 1941 as the "first date of commercial television in America." RCA's W2XBS experimental station operating in the 44 - 50 Mc/s channel 1 was relicensed as WNBT; CBS had been holding experimental license W2XAB/W2XAX for the Chrysler Building and the FCC granted them permission to use 54-60 Mc/s as WCBW (later to become WCBS-TV). Philco's W3XE was converted to WPTZ using 60-66 Mc/s although its official FCC sanction did not occur until September 14 (1941). No other stations received FCC permission to engage in "commercial operation" prior to the onset of World War Two (December 1941). There are many conflicting news stories concerning what viewers actually saw in New York City on July 1, 1941 and we'll leave that aspect of early TV operation for another chapter.

CBS continued their anti-commercialization posture even after the FCC made their decision. One press release issued in June 1941 included, "We are against premature commercialization" and they went on to cite "manpower and equipment shortages in the ramp-up to (world) war." They concluded, "CBS remains committed to the adoption of the NTSC format but would liked to have had provisions therein for color television."

Radio News for August 1941 admonished CBS's interest in color. "We couldn't help but feel that the sudden high pressure ballyhoo for color television by CBS was a sort of Technicolor red herring designed just to bide time until they have charted their course for more active participation in the video art." CBS in the same issue promised, "a tour of the Metropolitan Museum of Art (in New York City) with a color TV camera."

Between his initial June 1940 laboratory demonstration for CBS brass and August 1941, Goldmark had gone to RCA and ordered a special version of the new Image Orthicon camera tube. Goldmark wanted a tube for his concept of a color camera, and his "custom" product order included, "thicker mica on the surface" (of the pickup plate). Goldmark was discovering what RCA and a small number of others already knew - the sensitivity or ability of the camera tube's plate surface to turn light energy into electrons was the key to successful imaging. He believed that if he had a camera of sufficient sensitivity, his field sequential color system could be made operable with live studio presentations.

Some elementary understanding of how field sequential color worked now becomes important for what follows. To turn a camera scene into color requires that the electronics within the camera sees not one but as a minimum three separate images, more or less simultaneously. One of these will be the red tones, another will be the blues and a third will be the greens. Artists consider the "three primary colors" to be red, blue and *yellow* and various combinations of two or all three will produce essentially any color one finds in nature. TV cameras do not "paint" - rather they use the spectra of light as a source and take this spectra apart for transmission. Red, blue and *green* are the "primary colors" in light spectra - thus explaining the difference with our school child understanding of red, blue and *yellow*. The Goldmark camera had to "take the scene apart" and create three separate "electron streams," each one representing a color range. Goldmark used the original Baird and Ives "color filter wheel" to separate the image into three parts. The initial color wheel typically had three equal (1/3rd) filters fitted; one for each of the colors of interest (others would have equal numbers of each color but more "filter sections").

The color wheel was a mechanical device positioned in front of the TV camera's pickup tube. A motor with precision rotational speed control circuits caused the wheel to spin on its center and by adjusting the motor's speed you could select how many times per second each of the color wheel filter segments (such as the red 1/3rd surface area transparent filter) passed in front of the camera pickup tube.

When the red filter was between the camera imaging tube and the object being televised, only portions of the image with red tints were identified. Thus for that brief portion of a second, the electron flow originating in the camera would paint a partial image on a receiving tube screen representing nothing but red toned subjects. Then as the motor driven wheel rotated, only blue and subsequently only green objects would be "photographed" and create a flow of signal-electrons to the receiver.

If you spin the tri-colored disc fast enough, individual colors are no longer visible to the eye; the result of a peculiar eye-mind effect known as "persistence of vision." If the disc spins too slowly, the image "flickers" because the human eye is able to ever so briefly discern the separate color segments and as they change in succession there is a "flickering effect" the eye+mind sees. At operating speed, standing before the camera and staring at the rotating disc results in a "white" object - all three electronic-primary colors mixing at a rate where the eye's persistence of vision melds them into what you get when painters mix red, blue and yellow (white).

Goldmark wrote, "December 2, 1940 was a big day" and he went on to describe his first "live camera results." Meanwhile, "upstairs," CBS was indeed using the "color issue" to slow down (if they could not stop) the rush to commercial television. But there was another side to what CBS was doing; Goldmark the inventor. He had upper management support for his color development activities, and he wrote in "*Maverick Inventor: my turbulent years at CBS*" that his color project was pretty much left alone by top management scrutiny. In effect, as long as he could report (and publicly demonstrate) "progress," which in turn CBS top management could use as a tool against RCA and the commercialisation of black and white, all was well.

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In Maverick Inventor, Goldmark suggests that CBS used their W2XAX Chrysler Building 54 - 60 Mc/s transmitter for experimental color telecasts with FCC approval during 1940. Where all of this goes awry is when Goldmark's claims for advanced color work are compared with his own statements at that time and those of CBS management as late as June 1941. Our conclusion is that if we are going to accept and believe quoted material from past publications, we are perhaps safest by erring to the monthly trade press which was reporting events as they happened rather than a Goldmark autobiography assembled 33 years after the event.

Radio News for September 1941 reported, "CBS expects to turn in a formal report to the FCC on January 1, 1942 on their technical testing of color, for consideration relative to the standardization and commercialization of color TV." As this date would be after the Japanese bombing of Pearl Harbor, it is not surprising that no such report appears in FCC archives. Goldmark in his autobiography wrote, "It (bombing of Pearl Harbor) marked the end of our color work for the duration."

RCA's most influential color man was George H. Brown. If Goldmark was a "maverick," Brown was the perfect embodiment of a "company man" who did what he was told with a lifetime of achievement: 80 patents in his name, on the RCA Board of Directors for several terms, recipient of the prestigious Edison Medal and the de Forest Audion Award(s). His personal and highly detailed "*and a part of which I was*" (1982, revised) technobiography is a treasure throve of intimate and often very human reflections covering the period 1932 (when he joined RCA) through 1982. Andy Inglis ("Behind The Tube") characterises Brown as self promoting but the fact remains Brown, perhaps more than any single individual employed at RCA, persisted with color technology development until the final NTSC format was accepted in the 1950s.

Brown's reflections on Goldmark's color system provide far more insight into what it was and where it had limitations than anything Goldmark himself or CBS has ever made available for scholar study. Brown answers some of the questions which we have raised to this point; and, questions which challenge the accuracy of Goldmark's self-puffery memory.

Brown writes, "...both NBC and CBS carried out over-the-air broadcasts of color during most of 1941." For this to be a true statement, such tests logically had to be conducted using frequencies other than those assigned to NBC (44 - 50 Mc/s) and CBS (54-60 Mc/s). Why? Simply because the color designs in 1941 (whether RCA or CBS) required a 16 Mc/s bandwidth and neither CBS nor NBC had that available with their experimental (later commercial) VHF TV channels. There remains another possibility; either or both could have "tested" much reduced resolution color TV using the standard 6 Mc/s channel width available to each and this appears to have been the case. Brown points at some of the technical problems in this early era:

"Except for flattering the corporate egos of both organisations, the broadcasts were of little consequence since it was obvious that no color receivers were in the hands of the public and those few black and white receivers which had found their way into homes would not be able to receive the color signals in black and white because the circuitry in the receivers would not respond to the disparate line and field rates."

Which identifies one of the major design flaws in Goldmark's "idealistic" system. Yes, it required (in 1941) a bandwidth so great as to make it impossible for use in the already pioneered VHF band. But there were more serious challenges.

Brown: "In the 1940 broadcasts, CBS used a scanning of 343 lines in each frame with 60 complete frames or 120 fields per second. While the field rate for black and white television was 60 per second, it was necessary to go to a higher field rate for color to avoid flicker. Even

at a total of 120 fields per second, each primary color was thus transmitted at 40 fields per second."

And the key. "This rate was low enough to cause flicker for the average viewer at any brightness high enough for acceptable viewing."

Persistence of vision varies slightly from person to person but virtually 100% of those with sight see no flicker with a field rate of 50 or more per second. Americans brought up on 60 fields per second, when first exposed to British television (50 fields per second), will and do notice "flicker" for the first few hours of viewing - until their mind adjusts to the slightly lower frame rate. It is a peculiarity of the human mind that staring at a TV screen for extended periods of time will implant a 'flicker memory'."

Peter Goldmark in Maverick Inventor wrote: "I seldom go to the movies because I've never felt my eyes were strong enough. Looking for faults in television pictures put them under a strain."

And as George Brown so correctly noted, when the brightness control on a TV receiver of that era was advanced, the flicker rate becomes far more evident. Whether Goldmark's eyes were so permanently damaged by his "staring at TV screens" that he simply did not see the flicker is unknown. However, those who witnessed CBS color in that era were shown a small TV screen (never exceeding 7" in diameter) in a darkened room with the TV screen's contrast and brightness carefully set at what one suspects was "just below the flicker level" for the most sensitive of eyes.

By reducing the field rate to 40 per color (120 total per second with three separate fields - one for each color), CBS was battling not only persistence of vision limitations but resolution as well. TV images transmitted prior to the adoption of the NTSC-FCC compromise (June 1941) were more or less uniformly 343 lines per frame; post July 1, 1941 and the sanctioning of commercial telecasting, 525 lines per frame. CBS color produced an image of significantly reduced horizontal (side to side) and vertical (number of lines per image) resolution. CBS was caught in a maize of their own making. Goldmark was receiving top echelon support because his proposed color system had RCA in a defensive posture. This encouraged him to push harder to work out the defects of which there were many. In a sense, Goldmark was being "encouraged" by CBS brass to keep RCA's feet to the coals and there is little evidence to suggest that at any point in this "color period" (which would extend through 1951 in one form or another) that CBS Chairman Paley or President Stanton ever expected the CBS system to actually work. In their minds, if it kept RCA on the defensive and bought CBS additional time to work out their own TV networking plans, "it was doing exactly what they hoped."

The maize was this. If Goldmark increased the number of lines so as to improve vertical resolution, this would automatically increase the scanning rate and - the bad news - further reduce the horizontal resolution. It is a balancing act from which there is no rescue - changing any one element causes immediate repercussions in others. And this is how color TV would stagnate following the Japanese attack on Pearl Harbor.

A limited amount of television broadcasting went on during the war. Of interest to us here is the following. General Electric's WRGB in Schnectady was granted a commercial license on March 01, 1942 (although Televiser Magazine for January-February 1947 reported, "WRGB does not have an advertising rate card in effect - the station waiting until there are more receivers in the Albany-Troy-Schnectady coverage area." Televiser for May-June reported 550 TV sets in the service area.); New York City's Allen B. DuMont station (WABD) was certified for commercial operation July 28, 1944 and Chicago's WBKB was approved in October 1943. If new TV stations were scarce, interest in TV programming production was a major driver during the war. Two firms in NYC established TV production studios where the

various skills (lighting, audio, make-up, camera operation, sound, program production et al) were taught on a commercial basis. Within this framework, a number of institutional grade programs were turned out (live, or, on film - as tape was not yet invented!) in support of the war effort. DuMont's WABD in particular was very active in creating live studio shows to train air wardens, airplane spotters and other "homeland security" groups in the finer nuances of their adopted volunteer activity. TV activity was muted but hardly abandoned from December 1941 through the surrender of the Japanese.

Radio News reported on a survey conducted by Don Lee Broadcasting (operator of pioneer Los Angeles television station W6XAQ, later KTSL/KCBS) which claimed as of early 1943 the following statistics:

"Approximately 7,200 television receivers are in the hands of the public in the USA, centered around NYC, Philadelphia, Schnectady, Chicago and Los Angeles. As of 1 January 1943, the number of hours of scheduled programming per week in each area was:

New York City - 9 hours per week (split amongst 3 stations)

Schnectady - 10 hours per week (1 station)

Philadelphia - 4 hours per week (1 station)

Chicago - 4 hours per week (1 station)

Los Angeles - 6 hours per week (1 station)."

The last "new production line" TV sets to roll off of assembly lines occurred in January 1942 and even the build-it-yourself kit (3 and 5") sets offered by Andrea and others so widely advertised in the trade magazines during 1940/1941 disappeared from promotional view. Under the War Production Board dictum, it was no longer legal to build TV (or consumer radio) sets and this extended to offering such equipment for sale as "new" even if the item had been manufactured prior to the WPB ruling going into effect.

Of interest in our trail leading to the creation of color TV was a patent application (April 26, 1941) by Allen B DuMont Laboratories (granted December 23, 1943). In it DuMont described a trio of cathode ray (picture) tubes equipped with filters, or, embedded with colored phosphors and focused onto a common screen with three lens. DuMont would post-patent-grant call this system Trichromoscope and RCA would become cross licensed for use of the patent. Post war, late in 1946, DuMont had a variation of this with three separate cathode ray tubes enclosed in the same vacuum envelope which was demonstrated to RCA at Princeton (NJ) in November of that year. Whether RCA made use of this patent in their own develop of a projection screen color receiver (in the 1947-1951 period) is unknown.

Nothing further of significance occurred in the development of colour until 1946 when CBS renewed its efforts to use color as an excuse for slowing down the commercialisation of black and white TV.

In April 1946 Radio News reported:

"CBS and Zenith have both announced they will build color TV transmitters in Chicago in the near future. Zenith further reports it will only build color TV receivers when it enters the TV set market."

Zenith, a primary manufacturer of home radio sets prior to the war, through company founder and President Eugene McDonald, shared the CBS philosophy that any activity which slowed down the development of black and white television was good for the industry. But like CBS, Zenith was talking out of both sides of its mouth. First of all, Zenith had the most unusual experimental TV license in the country; for channel 1 Chicago (44 - 50 Mc/s). Zenith records ("*Trail Blazers to Radionics*" by Engineering Correlator E. Kelsey, 1943) suggest the TV transmitter operated from their plant located in XXXXXXXX with a maximum radiated power of 1,000 watts. Clearly this was an experimental station, not unlike Don lee's W6XAQ or NBC's W2XBS but for reasons untraceable the FCC had assigned it call letters of WTZR

as if it were a commercial TV station (normally the station's experimental call letters would have been W9X//). The FCC reason for the mixed-call-letters was Zenith's proposed use of the channel for testing of over the air pay television; a first in the world. Ultimately the WTZR transmitter would be donated with associated parts to an Indiana educational facility (1952). What is of interest here is that Zenith was in a position to have assumed the license for Chicago's TV channel 2 (commercial) frequency because of this experimental license (as Don Lee did in Los Angeles) but apparently because of the obstinate attitude of Zenith-boss Commander McDonald the firm made no attempt to do so. Oh yes - neither Zenith nor CBS would in fact follow through on their "promises" to build color TV stations in Chicago.

The next significant event was a series of hearings held in Washington December 9-13, 1946 and then repeated for a new audience in New York City January 27 (1947). The hearings were given a name of "UHF/Color Hearings" and they were a FCC response to CBS's continued urging that TV standards, if frozen for the 13 VHF channels established in 1941 through the guidance of NTSC, should not be repeated for the new (under consideration) UHF channels. The FCC, keen to create a television channel allocation scheme which would guarantee every home in America access to between 1 and 3 (as a minimum) off-air TV channels, recognised that VHF channels 1 through 13 were simply not "wide enough" to allow a national TV channel system to operate. Post-war, the UHF region, from 500 to 900 Mc/s, would be first-time assigned to specific services - the direct result of significant new technology developed during World War II. If TV was going to have some or all of this spectrum reserved for its use, careful planning was required. Alternately, dozens of other potential users (including two-way public safety radio, air to ground communications, telemetering, radar) were desirous of having some of this spectrum set aside for their use. The "UHF/Colour Hearings" were designed to create a written record that would allow the Commission to move ahead with allocations in the 500 - 900 Mc/s region.

CBS and fellow travellers such as Zenith were still hoping to stop black and white TV before it ran away at the consumer level. In 1946, according to the RMA, 11,651 TV sets had been manufactured and most forecasts suggested ten to twenty times that number in 1947. For CBS, stopping the black and white TV explosion was a major concern. The hearings allowed CBS, Zenith and a small handful of disgruntled manufacturers to urge the Commission to reserve the UHF spectrum for color-only transmissions, using the wider channel bandwidths Goldmark's TV system demanded. CBS continued to tell the press, "We will not enter television until it can be color and this will only happen at UHF." The FCC seemed to be leaning in this direction throughout the hearings by pre announcing, "500 - 900 megacycles will be reserved for color television broadcasting."

Actually, although Goldmark does not explain the subject, by the "UHF/Color Hearings" CBS had finally had time to work out the gulf between limited resolution color using a 6 Mc/s bandwidth and the on-paper projected wideband UHF color transmission system. What had been a 343 line 120 fields per second system crammed into 6 megacycles in 1940-1941 matured to a CBS demonstrated 525 line, 144 fields per second system in 1946 using slightly over 12 megacycles bandwidth. Goldmark ignores what his developmental processes were leading to this technology improvement in "Maverick Inventor" and RCA's Brown apparently could but observe from afar what CBS was doing. Brown writes:

"CBS radiated a color signal from a rather low-powered transmitter located near the top of the Chrysler building. During the course of the hearing, CBS gave a number of demonstrations at carefully selected locations and produced very pretty pictures of rather low brightness to avoid the flicker problem inherent in the field-sequential method. However, no specific data were produced to show how to lick the apparent engineering problems." The insinuation is that CBS was now using a UHF (500 - 900 Mc/s) region transmission to

conduct these tests. What is of particular interest is that CBS had reduced the original 16 Mc/s channel-width requirement of 1940-1942 to "just over 12 Mc/s" which meant that between 450 and 900 MHz, the FCC - if it adopted the CBS plan - could now create something approaching 37 TV channels in lieu of the original 26 maximum. Reduced TV channel widths meant an easier job for FCC planners and of course this would have appealed to the bureaucrats.

RCA escaped from the first CBS attack in 1940-1941, and having learned a lesson from the encounter, was now hard at work on its own version of color. Brown, again:

"RCA however was very concerned about CBS's blind acceptance that UHF channels would work."

Almost nothing was known about 'UHF wave propagation' - how signals in the 500 - 900 Mc/s region would fly through the air, curve behind buildings and other obstructions, bend over hills and mountains. Brown wrote:

"I had already developed a feeling from some preliminary (RCA conducted) wave propagation tests that the (UHF) transmitter scheme could only take us down the road to disaster."

RCA early in 1946 applied to the FCC for a special experimental license (KC2XAX) to utilise a frequency of 288 Mc/s for "propagation tests" with a transmitting antenna mounted slightly higher than the NBC channel antenna on the Empire State Building. Testing done in the mid 1930s by RCA engineers had developed a sizeable record of data concerning how VHF waves travelled in the region 30 to 100 Mc/s and various technical papers published in the Proceedings of the IRE (Institute of Radio Engineers; now IEEE) were the foundation for any serious student of the subject. What those tests suggested, quite properly, was that as the frequency of transmission was increased, an entire new layer of data emerged. Signals at 40 Mc/s which easily flowed through and past buildings and other physical objects in the way simply were not working at 100 Mc/s. Logic suggested, absent tests, that as the frequency of transmission grew to 200, 300, 500, or 900 Mc/s, this "blockage of reception" artefact would become greater, not lesser.

While RCA was conducting tests at 288 Mc/s (not quite UHF but 3 octaves in frequency higher than any existing New York City TV transmitter), CBS had created a 500 Mc/s transmitter on the Chrysler Building (W2XCS) through which they were testing and modifying their proposed field sequential color system. Brown wrote of the two systems being tested during 1946:

"RCA carried out these 288 Mc/s surveys throughout the summer and fall of 1946 so that by the time CBS demonstrated their UHF color transmissions, we were sufficiently sophisticated to realize that CBS had very carefully selected locations to show the highest possible performance and we were able to point out to an industry team many spots where UHF reception was hopeless.

"(Later) in 1947, we thoroughly explored the performance of the UHF spectrum by placing two more experimental transmitters on the Empire State Building, one operating near 500 Mc/s and a second near the top at 850 Mc/s. Our experiments clearly indicated that successful transmission in the UHF channels would require transmitter powers far greater than that used by VHF stations and far in excess of the power which could be generated by 1947 technology."

Goldmark: "A shift of (TV) standards one way or another could benefit one corporation over another and decide the pattern of the TV industry for years to come. It is no wonder that there was confusion between the private and public interest, and there was constant investigation or threats of it (by the FCC)."

Goldmark's war years were largely spent involved in working out techniques for dealing with the German's radar systems. He created or helped create both radar jamming systems and the technology that used precisely formed pieces of aluminum foil dropped from bombers to confuse the German radar sentry. He was "on loan" to the United States government although CBS kept his position open and continued to pay 20% of his pre-war salary to help make up the difference to military advisor pay. It was during this effort that Goldmark was introduced to the most recent developments in the ultra high frequency region. He returned to New York after VE day filled with new concepts and an enthusiasm for UHF which bordered on passion. He proposed restarting the pre-war CBS proposal for color TV, using UHF channels, and CBS management saw this as an opportunity to further retard the growth proposed by a RCA fuelled NBC promoted lunge into VHF black and white TV.

He wrote of his first weeks back at CBS, "I improved the mechanism of the whirling disc and watched the color come through true and fine. I felt that with a little work we could coach color into UHF bands and be the first to bring commercial color to viewers. Management had bought it once (1940) - *why not again*?"

CBS head man Bill Paley was asked for his approval; something that Goldmark had not previously been asked to seek.

"He listened with an air of mixed impatience and interest and quickly told us he loved the idea. I would discover later that love and hate with Paley were emotions that quickly followed one another. Paley needed a block-buster device. Competition was then intense for (network radio) audiences and here might be the answer to (RCA's David) Sarnoff's belligerent push to promote black and white TV as well as (NBC) radio" to the detriment of CBS.

Now Goldmark returned to the FCC where when last visited they had been urging him to complete the development of his color system which he took as an indication that they were anxious to approve it as an alternative to the RCA backed black and white service system.

"All you need to do is prove that you can transmit and receive UHF, one of the Commissioners told me, and if you can do that, then we'll consider a CBS proposal for a hearing."

All of this was by way of leading up to the December 1946 "UHF/Color Hearings" which would pit Goldmark against the boys from RCA.

Brown of RCA was spot on when he dissected the CBS technique of "hand picking UHF demonstration sites" for the FCC side-show. Unlike RCA which Brown and others have written was "primarily interested in the worst case, not the best one," CBS under Goldmark was more interested in getting the FCC approval than total honesty in presentation. Goldmark wrote about the FCC demonstration as follows:

"The place chosen for the major portion of the demonstration was the Tapan Zee Inn at Nyack, a luxury hotel on a hill overlooking the Tappan Zee, the widest part of the Hudson River. The hotel was about forty miles from the CBS transmitter on the Chrysler Building in New York City, a reasonable distance to prove the point that color was not only feasible but practical. I knew our company was lagging behind others in the rush to market television, and was prepared to invest a great deal of money in the future of color.

Televiser Magazine coverage quoted CBS President Frank Stanton as follows:

"If the Commission acts favorably on the CBS petition, we intend to convert our present extensive black-and-white operations (WCBS-TV) into ultra high frequency color television as rapidly as possible. We are prepared to inaugurate a partial color television program schedule within a few weeks of a favorable Commission decision."

And his other side:

"Should the Commission rule adversely upon our petition we are not prepared to expend further substantial corporate energies in this direction."

For the record, WCBS-TV was operating on a very limited schedule (1 to 3 hours daily, 4 days per week), had only 3 commercially sponsored programs in January 1947 (WNBT/RCA had 17 commercially sponsored programs, averaged 4 hours daily, 6 days per week).

The "special FCC" field tests by CBS at Tappen Zee Inn, as remembered by Goldmark:

"Charles Denny, the new FCC Chairman, sat mesmerised as our instant starlet in the special CBS color studio, Patty Painter from Beckley, West Virginia, filled the tube. She was 19, auburn hair, and every detail of her face and figure was memorable and as clear as anyone could possibly ask."

Denny and his staff, hardly closed mouthed, let it be known they were extremely impressed. CBS would get the hearing it wanted. And RCA turned from adversarial to vicious. RCA introduced their four-transmitter scheme (one each for red, blue, green and sound) and during the hearings in Washington (and later New York) claimed their system for UHF was superior. Unfortunately for those who saw it, including FCC personnel, it was not even close to the CBS quality.

"RCA described (at the hearings) a color system which was not sequential but could be called simultaneous." Where CBS was breaking up the origination point's TV image into an repeating series of red-blue-green images and "time sharing" the transmitted wave giving each of the colors 1/3rd of the total transmission time, RCA had a different approach. Brown continued:

"This consisted of four separate radio transmitters, one for each primary color and one for the accompanying sound. The arrangement needed a 14 megacycle band but the RCA lawyers insisted that if CBS could crowd its (color) signal into twelve megacycles so could RCA.

"The lawyers won this round, convincing the engineers they had to find a way to be no wider than CBS in spectrum usage. The crowding into 12 megacycles was made possible by the 'Principle of Mixed Highs' which had been espoused by (RCA's) Alda Bedford. Bedford's studies showed that for very fine picture detail the human eye distinguishes changes in brightness but fails to sort out changes in color. As a result, the high-frequency components of red, green and blue signals could be mixed together and added to the green signal. Hence the green transmitter (one of the four total) would transmit at full bandwidth while the red and blue would be spectrum limited, thus saving precious spectrum space." In 'Basic Television' written by Grob of the RCA Institute (1948), the system is explained as follows:

"A separate carrier is employed for each of the color signals with the green signal used to provide a standard 6 Mc/s channel with the FM sound." A diagram illustrates the green carrier at 519.6 Mc/s, FM audio subcarrier at 524.1, blue subcarrier at 526.3 and red subcarrier at 528.2 Mc/s. At the transmit end, the system required three separate (filtered) pickup tubes, three parallel chains of amplifiers and very complex synchronization to insure each image was in sequence and properly timed. In the accompanying complex receiver, three cathode ray tubes each fed by a separate chain of IF (intermediate frequency) amplifiers, video amplifiers and then fixed filters to a housing mounted mirror which somehow was expected to focus all three images properly as a converged display on a transparent frosted screen.

RCA's Brown had no fond memories of this approach.

"I doubted the three UHF transmitters bearing the information regarding the three primary colors could be made to function as described by RCA. My opinion was not solicited but I am sure my disapproval was in evidence."

RCA elected to demonstrate this kluged system on January 29, 1947 at the Princeton (NJ) laboratory. Brown:

"Small low-power transmitters fed into antennas on the roof. The demonstration scene, the 'Penn's Neck Community Club', was about one mile distant. The demonstration was less than impressive. The receiver used three picture tubes and a lens to project the picture onto a frosted glass screen. The pictures were fuzzy with color fringes due to poor registration (registration: the challenge of making each of the three projection tubes be in exact overlay with the other two, a problem still not resolved with many consumer brand projection TVs).

"Part of the demonstration was designed to show compatibility, the ability to view the color signal in black and white on a black and white receiver. Of course a (UHF to VHF) frequency converter was the first requisite but RCA soft pedalled this point. The signal from the full 6 Mc/s bandwidth green transmitter was the one to be shown in black and white. The effect was not bad when a slide of a green parrot was used for then the black and white picture had a rather good grey scale. Before long, some enemy sneaked into camp with a slide of a brilliant red parrot, a parrot completely lacking a single green feather. The result on a black and white receiver was a coal-black parrot with no shades of grey and no trace of detail.

"Then came the demonstration of the mixed highs. The audience viewed the color pictures on the receiver while a switch was thrown at the studio on command by telephone from the meeting room. The reaction was mixed. Some viewers were impressed by the addition of fine detail while others did not feel the improvement to be astounding. Some days after the demonstration, we found a defective switch had *failed* to insert mixed highs *at any time*!"

This had two immediate effects. First of all, as the red, blue and green were being transmitted simultaneously (as opposed to sequentially), the TV transmitter and the TV receiver now required totally separate signal processing "chains" for each of the component color parts. Where a black and white receiver required only one video amplifier "string" the RCA "field simultaneous" receiver required 3 strings as a minimum. What had been a 26 tube receiver suddenly became a 40+ tube receiver. They were bigger, used far more electricity, and created new challenges for field servicing. But this was a prototype system and perhaps it would be improved.

Secondly, by combining all of the colors in the "wideband" green signal simultaneous stream RCA had laid the foundation for "compatible color." What was missing in the CBS system was that when CBS switched their color "on," every black and white TV set in the land went to squiggly lines on the screen; no picture at all. There would be a solution to this, but it would add expense to new receivers and the increasingly larger universe of black and white sets would be required to spend money to receive the CBS color programs in black and white. RCA's "Mixed Highs" approach for the first time offered the possibility that color could be "compatible" with black and white - that color sets would have color and black and white would have black and white of the same telecasts. In 1946 - 1947 it was not quite to that point - yet - but it was coming closer, without requiring existing black and white sets to spend money for a "black and white translator."

Goldmark had designed a prototype dual-purpose receiver - color at low band (channels 1 through 6) and color at UHF. He said, "this will be slightly more expensive than color alone" but gave no indication of what "slightly more" might mean. He also produced but did not demonstrate a "converter" which he said would allow the existing universe of black and white sets to view CBS color in black and white.

CBS came out of the demonstrations very buoyant; so enthused that Paley ordered CBS to return the four FCC granted construction permits which the corporation held for to-be-built VHF network stations in such major cities as Chicago and Los Angeles. Paley told the press, "We are so certain that full color using UHF is the right way to go that we are giving up all but our presently operating New York City channel and when the FCC will accept our

applications, applying for UHF channels in the same markets." It would be a decision he would live to regret.

CBS's Stanton was considered a clairvoyant when it came to reading FCC actions in advance of their announcements. Immediately after the demonstrations for Chairman Denny and his staff Stanton, according to Goldmark, "thought we were in." But RCA had a few unused weapons in their arsenal. First, they told the press, "There are 250,000 sets in America at this time. These set owners who wanted to receive CBS color programs would have to buy an 'inefficient, ugly and expensive' converter to view color broadcasts on their black and white sets."

In fact there were not even 25,000 TV sets in America but nobody bothered to challenge RCA's pronouncement.

The FCC on January 30, 1947 met and then voted later in March on the CBS petition which if passed would have allowed UHF 12 Mc/s channel widths and color TV for the first time. CBS was shocked when the FCC said, "no - the CBS color system is premature" and then they reaffirmed the old black and white standards and VHF only.

Radio Craft for May 1947 reported it this way:

"Color television is not yet ready for commercial exploitation, the Federal Communications Commission has decided. The FCC decision came after several hearings in which Columbia Broadcasting System led the proponents of immediate color television and RCA spoke for those who believe color is not yet ready for the public. Both sides backed their arguments with showings of color television.

" 'The Commission cannot escape the conclusion,' " the FCC said in a fourteen page decision, " ' that many of the fundamentals of a color television system have not been adequately field tested, and that need exists for further experimentation.'

"Television broadcasters and manufacturers interpreted the ruling as giving a green light to black and white television and some predicted that greatly expanded production would result almost immediately."

Six months later, mid-1947, there was political fallout as well. Goldmark notes:

"We felt we had been dealt a foul blow. Everyone in the CBS camp noted cynically that six months later (FCC Chairman) Denny accepted a post as vice-president of NBC, which is wholly owned by RCA. A subsequent Congressional investigation of the affair resulted in a change of FCC rules and an amendment of the Communications Act, prohibiting a commissioner from representing a company before the commission for a year after resigning from the FCC."

Seemingly, this would be the end of the color TV story but in fact it is merely a seventh inning stretch. It was March 1947 when the FCC said, "go back into the field and perfect the system." At that very point in time, according to the RMA 29,890 TV sets were in public hands. And according to Televiser Magazine, 9 cities had 11 operating television stations (New York, Philadelphia, Chicago, Detroit, Los Angeles, Washington [D.C.], Schnectady, Cleveland and St Louis). If CBS had a "plan B" beyond their haughty promise to not pursue television unless it was UHF color, it was not evident.

Through 1947, an additional 7 commercial TV stations would begin operation and at year end, 150,000 TV sets would be in public hands with 17 TV stations. AT&T would begin the task of interconnecting stations and markets using a combination of coaxial cable and 4,000 Mc/s terrestrial microwave repeaters. ABC, which had begun modest TV production in 1946, would cease programming during 1947 to concentrate on getting TV stations on the air; they had none at the time! In terms of advertising revenue and program production, NBC would lead followed by DuMont but neither would be profitable in their television network

operations (Dumont's 1947 financial statement showed $775, 235 as cost to operate its TV broadcast and network operation, not well offset by $71,184 in income; a loss of $704, 051).

RCA made it clear it was not abandoning color research. Dr. C.B. Jolliffe, VP in charge of Princeton's RCA Labs, told the press in March 1947:

"We propose to carry on with our research and development work in monochrome and color with all of the resources at our command, regardless of the status of operations, manufacture or non adoption of standards." Prior to the FCC decision turning down CBS color, he had made an almost identical statement peppering it with, "If the FCC does approve the petition, we shall still carry on with our research to perfect a '*compatible*' color system."

Goldmark of course believed the FCC had seriously erred, and responding to allegations the weakness of his system was the mechanical rotating color disc required for both the transmit and receive ends of the circuit, he said:

"The CBS sequential color method is a universal one which functions not only with the single tube pickup and single tube reproduction methods in operation today, but will also function interchangeably with three tube methods, either pickup or reproduction, in the event future development should prove them to be workable and economically desirable."

George Brown wrote about RCA's attempts to make the rotating plastic disc into a workable system, "The color disc mounted in front of the image orthicon camera tube was almost seven inches in diameter. At the receiver, a disc twenty-two inches in diameter carried six color filters (2 for each color) and rotated at 1200 revolutions per minute (20 times per second) in front of a 9 inch kinescope picture tube."

With some slight variance, the receiver picture tube disc was a device 2.444 times the diameter of the picture tube. Thus a 20 inch tube, available from DuMont required a disc 48.9 inches in diameter - more than four feet. As the picture tube size grew, so did the disc size. At the same time the horsepower of the electric motor required to rotate the disc grew proportionately and the noise of the rotating color disc plus the rapidly spinning armatures of the motor became quite objectionable. And none of this reduced the "flicker effect" which was inherent and basic to the flawed Goldmark design. That the FCC came close to approving this system in 1947 seems quite depressing; that they would in fact actually approve it for commercial use in 1950 is almost beyond belief. But we are getting ahead of our time line.

RCA apparently was more interested in the future that UHF held than some specialised use of color TV there. This was driven by the FCC which by the fall of 1947 was increasingly concerned that the original channels 1 - 13 were inadequate to provide a true national service of even one TV channel for every home. This "squeezing of the megacycles" would be exacerbated early in 1948 when the commission eliminated TV channel 1 (44 - 50 Mc/s) from those available to television in a trade that kicked non-TV users out of channels 7 - 13 reserving these upper channels (previously shared with other services) for TV only, coast-to-coast. The spectrum for TV channel 1 had always been controversial, subject as it was to long distance "skip" interference and badly corrupted in metropolitan areas by motor cars and electrical systems. Late in 1946, NBC's WNBT and Don Lee's W6XAQ had already converted off of channel 1 (WNBT to TV channel 4 - 66 - 72 Mc/s and Don Lee to channel 2 - 54 - 60 Mc/s) so the loss of channel 1 was no special hardship except to stations in markets such as Riverside (California) and Lancaster (Pennsylvania) where the FCC had assigned channel 1 as the only available TV channel.

At CBS, Chairman Paley was frying new fish. He with the help of tax advisers had worked out a clever scheme that allowed prominent radio personalties (Jack Benny, for example) to establish their own production companies. Then he changed the corporate policy at CBS to allow these self-centered one-man corporations to create and produce their own radio shows without direct CBS involvement. What this meant was he was able to attract to CBS radio

(and later to CBS-TV) many of the NBC radio stars of the day and for a brief period of time tip the radio audience scale in favor of CBS. For Jack Benny, it was as much as 50% more money in his pocket and at pay scales approaching $50,000 a week for a single 30 minute radio show, 50% was a heap of cash. Paley was apparently so pleased with himself that he momentarily ignored the tremendous growth going on under his nose in the television world. NBC, at the same time, did not expect the CBS tax avoidance scheme to pass IRS muster (it did) and while silently chortling about the hot water CBS would - they believed - suddenly find themselves bathing in, was betting that it would only be a year or two before radio was a has-been medium. In a nutshell, CBS was betting on radio and NBC had their money on television.

Midyear 1947. The FCC may have passed on color at UHF but not on UHF itself. As new stations were signing on the air, a new type of unexpected problem was appearing; interference between stations on the same (such as channel 4) and adjacent (such as channel 3 to 4) channels. Same channel interference was called "cochannel" or CCI for short. When the FCC elected to assign 13 channels to television service in 1941, some assumptions had been made about the minimum mileage separate (distance) between stations operating on the same channel, or on adjacent channels. The assumptions were based upon knowledge gathered in the 1930s using television transmitters of relatively low power (5,000 watts was high power at the time) and often with TV transmitting antennas located only a few hundred feet above ground. Moreover, TV receivers were very insensitive because they lacked some of the refinements that would be discovered during World War Two. Now, in mid-1947, it was increasingly evident that some serious errors had been made with those assumptions. Stations as close as Detroit and Cleveland (105 miles apart and most of that across Lake Erie which readily propagated the TV stations in both directions) or Washington to Lancaster (only 90 miles apart) had been assigned the same VHF channels. If you lived in downtown Detroit or downtown Lancaster, everything worked fine. But if you lived in between two cities using the same channel, your TV screen was more often than not a blurry mess of horizontal lines as the two TV signals fought it out inside of the TV receiver to "dominate" the receiver's signal processing circuits.

The FCC decided to do what they did best at the time - schedule a hearing to take "expert testimony." One of the proposals FCC engineers were floating at the time was the concept of closing down VHF totally and moving all TV to UHF - where, they believed, this sort of interference would be far less troublesome.

Brown found the FCC's plan disturbing.

"...the (FCC) Commissioners still clung to their respective fantasies of making UHF 'equal' to VHF" and "as late as June 1956 the Commission stated it was convinced it should undertake an analysis of the possibility of improving and expanding the nation-wide television service through the exclusive use of the UHF band without the concomitant use of the VHF channels. They were still dreaming."

Brown, RCA and the industry could be excused for being confused by the FCC's stance. Radio-Craft for September 1948 reported:

"TV allocations will have a profound effect on broadcasters and receiver owners, said John A. Willoughby, acting FCC chief engineer. Mr Willoughby said the lower end of the present television band (channels 1-6) may be wiped out in two years, to make room for fixed and mobile services which require the space. Channels 7 - 13 will be used for TV for perhaps ten years, but only for 'low definition' transmission. The area above 500 mc will be used for high-definition, black and white and color transmissions, which may come in two years. According to Mr Willoughby, a television station starting operation on a low frequency channel in the next two years is faced with possible loss of its transmitter and antenna

investment. It follows that receiver owners would also take some loss, even if only that required to purchase conversion units."

The 1947 problems relating to interference between stations and channels was but the tip of the iceberg. With only 17 TV stations actually on the air at the end of 1947, the start-up of 15 new, additional, TV stations during the first half of 1948 would drive the Commission's engineers up a wall. Each new operating station further muddied the waters and while on one hand the new service areas opened up for the first time (such as Dayton and Richmond) meant millions of new homes were being exposed to first time local TV, on the other hand the additional transmitters were adding to the "pollution" of the channel space.

RCA apparently had mixed feelings about UHF, mostly dominated by a certainty that if the FCC rushed into use of the "ultra highs" without a foundation of wave propagation knowledge it would be, as Brown so aptly recorded, "a disaster." The logic underlying what RCA did next is difficult to comprehend. Brown:

"During the summer of 1948 a UHF transmitting antenna was constructed and mounted above the WNBW turnstyle (Washington, DC). Frequency converters (UHF to VHF) were designed and went into selected homes in the Washington area, 75 in number. We experienced many failures of the UHF (504-510 mc) picture transmitter since we were using a transmitter tube designed for the VHF band and were pushing the tube to the limit in order to operate in the UHF band. A panel truck with an awesome assemblage of measuring gear and television sets began a thorough comparison of UHF service in the area rendered by WNBW on channel four. We gathered a mass of data concerning everything we learned in Washington and assembled it in a thick document called 'The Washington Field Test'."

Of course some (read - many) of the 75 locations receiving test UHF antennas and converters were folks employed by the FCC. Not a few others were influential people in the television business, such as Sol Taishoff the editor and publisher of the industry's trade magazine Broadcasting. RCA was walking the most delicate of lines here. Intuitively, they wanted UHF to work. But more than that, they wanted the handful of influential folks centered in and around Washington to realise that a serious UHF effort was not a cake walk and there were so many unknowns that a premature move to UHF was - well, just as bad as a premature move to color.

That "delicate line" is best illustrated by an incident during November 1948. After a summer of testing in Washington, and reams of collected data, the Institute of Radio Engineers invited George Brown to report on The Washington Field Test. Brown, with the virtually unlimited resources of RCA, conceptualised a one hour demonstration built around use of the 500 mc test transmitter and a second transmitter created especially for the occasion operating at 850 mc. He planned to use the 850 mc transmitter, fed from the extensive production center at WNBW, a staff announcer from NBC, and the 500 mc transmitter to create a parallel set of transmissions which would be displayed on 8 RCA television receivers on a stage at the auditorium of the Potomac Electric Company. There was a full scale dress rehearsal on the afternoon of the demonstration and everything worked fine. The 850 mc transmitter was only video, relying on the 500 mc field test transmitter for the audio while graphs and charts and photographs flashed on the 850 mc receiver screens. Brown, describing the evening of the presentation:

"While we were dining preceding the demonstration, a phone call from the transmitter room. The 500 mc picture transmitter had given up the ghost. Mildly disturbing, of course, but not enough to really excite us. We rose to the occasion and decided to transmit the picture portion on our 850 megacycle marvel and receive the sound from the (still functional) 500 megacycle sound transmitter. Just two minutes before the appointed time for the

broadcast, I was again called to the telephone. 'This is Archie at the transmitter. The sound transmitter just conked out.'"

Meetings of the IRE attracted the best of the best in telecommunications. An IRE meeting in Washington attracted the very best of the best, the folks who by their credentials could make or break a new concept merely by the position of a raised or lowered eyebrow. Brown and RCA participants in the IRE had their own pecking-order status within the IRE and it was all on the line.

"I hastened back to the auditorium just in time to see curtains open on eight receiver screens, followed by an NBC announcer who silently moved his lips. I did the only thing possible short of quietly leaving the hall and going to bed. For one hour and 30 minutes, not one hour as my colleagues planned and as the rehearsal ran, in the WNBW studio they held up antennas, pointed at charts, showed slides and gestured violently to make a point while I stood on the stage and supplied sound for the program. Fortunately nobody advised the fellows in the studio they were taking part in a soundless broadcast or it would have been difficult for them to carry on so well."

The FCC on September 30, 1948 came to a reasoned conclusion. Radio Craft reported:

"Television grants were halted by the FCC for a six month period. During this time no action will be taken on applications for (new) TV station licenses. In announcing the freeze, Wayne Coy, FCC Chairman, said that evidence presented at an industry-commission conference held in Washington September 13 and 14 raised serious questions about the present and proposed frequency allocation scheme. An engineering conference will be called to discuss the question; meantime, no further allocations will be made.

"Operation of the 37 stations now on the air and construction permits previously authorised will remain unaffected. Mr Coy emphasized the usefulness of presently owned and marketed television receivers will not be impaired."

In fact, six months would turn into just short of four years and during that time (through mid-1952) all TV growth would be limited to the reach of 108 TV stations which had received construction permits before mid-September 1948. What perhaps should have been a six to twelve month "freeze" on new applications was about to become hopelessly complicated as the industry and Commission wrestled not only with juggling TV channels about, but also with adding new UHF channels and - color. The color question was still a roadblock to the ultimate fabric of television in America.

CBS's Goldmark found a temporary shelter for his field sequential color system through the American Medical Association. It was an unusual marriage. Joseph DuBarry, an assistant to the President for Philadelphia based Smith, Kline and French Laboratories, would be given credit for the concept. It was simple enough.

Television cameras in an operating theater, microphones inside of surgeons surgical masks, a string of closed circuit TV monitors allowing medical students and practicing doctors to "be up close and intimate" with the skilled hands of the doctors performing the operation. Attempts dating back to 1946, using black and white equipment, had been only partially satisfactory because like the orange and purple flowers side by side in a vase, anything and everything covered in blood had the same grey texture on the screen.

Color was a possible answer. All involved agreed televising intricate operations for medical personnel was a goer, but only if those watching could distinguish between an artery and a scalpel.

Goldmark created a test system which he displayed to DuBarry and a small select group of surgeons including Dr Isador S. Ravdin of the University of Pennsylvania. The demonstration was done using a Japanese manufactured full-sized plastic dummy of a woman's torso,

complete down to the inner organs which were only revealed after the quasi-doctors acting out the operation cut through the human colored skin.

Dr Ravdin, according to Goldmark, "immediately ordered a set-up for the university hospital. We devised a small camera on a long beam that could be lowered over the patient on the operating table by remote control, so as to not interfere with the surgeon. Zenith quickly built us a receiver (monitor) with a 12 inch picture tube and (magnifying) lens. One nice thing I later learned was that coming to us (CBS), that locked out RCA with whom they had been negotiating a black and white camera (system).

"The climax of our (CBS) medical television experiments came in December, 1948 during the American Medical Association's annual meeting in Atlantic City. Zenith built twenty color receivers financed by Smith, Kline and French. We set up the equipment in the operating rooms of the Atlantic City Hospital and ran 'shows' piped to 15,000 doctors in sections of the convention hall. The operations were so realistic on the TV screens that some of the viewers, including doctors, fainted in front of the television screens. (As a result) of the accolades, morale at the (CBS) lab picked up and we actually thought we might sell cameras."

But there was no dissecting the mind of Chairman Paley. Upon his return from the highly successful Atlantic City demonstration, Goldmark received a call from the Chairman's right hand man.

"Bad news, I'm afraid. The chairman has decided he has no further use for the lab. He'll give you thirty days to shut down - and lay off the staff."

It was December 1948. The "temporary freeze" on FCC granting new TV application construction permits was now 3 months old. The number of TV stations operating, those fortunate enough to have been granted a construction permit before the freeze was announced, was now 44 and the number of TV receivers in consumer hands was passing 1,000,000, growing at a rate in excess of 130,000 monthly. Not one of these could receive color.

Peter Goldmark had been told to wind up CBS Labs. Chairman Paley gave him 30 days, he negotiated 90 and then in an act of desperation did nothing to start the process of closing up.

"(in an air of depression) I suddenly remembered that in Atlantic City during the medical convention several members of the FCC had come up to me and bemoaned the unhappy fate of color broadcasting. I was surprised to learn at the time that color had more support than I realized despite the commission's decision against it in 1947. This set me to thinking that if CBS brought color back to VHF, as they had before the war, instead of the more controversial UHF band, the FCC might possibly urge me to come back to them with another proposal for a license."

And Goldmark's key revelation from Maverick Inventor:

"In a flash it occurred to me that by a simple mathematical transformation of the video signal, I could put color into the VHF band and make it sharp and even greater clarity than before. The net result after a month of weight-losing, intensive concentration, and frenetic activity was the development of a new method of broadcasting color in the low frequencies and at the same time making the image crisper than it had been. We called the sharpening process 'crispening'. What we did was to electronically enhance the signal to emphasize the image sharpness over the rest of the information carried in the signal. It worked well."

Well enough that, for the third time in his life, Goldmark was able to attract the approval of CBS Chairman Paley. Quite by coincidence, it went through Paley's protégé Stanton and then to the Chairman only hours after a delegation of US Senators had visited with the big man to urge that CBS "do more with the color system shown at the AMA convention." Paley was known for his "love and hate" snap decisions and for the third time in his charmed life, Goldmark through Stanton reached the man at a peak of "love."

The next stop of Goldmark and Co was a private demonstration for FCC Chairman Coy and fellow commissioners. Goldmark reports:

"The demonstrations were so good that CBS took out full-page ads announcing color shows for the public in Washington. The reaction was very positive and Senator Edward Johnson, chairman of the Senate Commerce Committee and a 'color now' advocate promptly demanded that the FCC clear the way for color before the public became saddled with black and white sets."

Goldmark: "From then on things happened fast."

Perhaps, but before we drop ourselves into this grand finale race to the finish, some observations from George Brown and his RCA cohorts who were not quite convinced Goldmark had "developed a *new method* of broadcasting color."

Brown: "CBS proclaimed they now had the secret of confining to a single (6 megacycle width) television channel by means of new methods the details of which were not disclosed. We visited their transmissions, dissected what we saw and scratched our heads. The results were 405 lines, 144 fields (48 per second per color or 24 frames per second) and this told us that the vertical resolution must be not more than 77% of a normal black and white picture (405 lines versus 525 lines) while the horizontal resolution could be no more than 55% of that of a black and white picture. We constructed a pair of field sequential receivers complete with whirling disks and moved one to a rented bedroom at the Washington Hotel in downtown Washington in order to monitor the broadcasts over CBS affiliate WTOP. Those in attendance agreed the color rendition quality was very good but the picture was fuzzy (lacking in detail - a direct result of the significantly reduced horizontal and vertical detail available). And we were bothered by a constant picture flicker since we were using a quite bright picture tube, brighter than CBS usually used in their demonstrations."

Yes, Brown was Goldmark's nemesis and it might be suggested that he was biased against everything CBS did. But history assures us of his technical integrity and while his bias may have been real, his technical correctness was almost always spot on. He reported what they found to RCA brass. Brown would observe, "We were facing skilful competition."

In January 1949, 51 TV stations were operating in 36 markets and Televiser Magazine reporting on RMA/RTMA TV set production claimed 1,200,000 TV sets were in the hands of the public. Moreover, new sets were going into homes at the profound rate of 140,000 per month. The FCC called for full scale demonstrations and then hearings to begin in September 1949 which would be the start of month 13 from the date the FCC froze all new station applications. Senator Johnson may have been an advocate of "color now" but his real advocacy was for 'TV now'. His home state, Colorado, had been "frozen out" of TV in 1948 and his constituents were daily berating his office demanding access to the video medium. He correctly saw a decision on color as holding up even black and white TV for Coloradians.

The color TV debacle was about to move into high gear and the final curtain was less than a year away. We'll give away the result up front because most already know it. CBS won against RCA (and weak third ran California firm CTI).

The first public demonstrations involved a dual test shortly after the hearing opened on September 26 (1949). CBS, CTI and RCA were each required to demonstrate color TV on receivers of their own design from two different sources. First, from a coaxial cable that linked New York City and Washington, and next, from a local TV station. The coaxial cable test was to answer, for the FCC's peace of mind, whether any of the three systems could be

inter linked between cities using the AT&T coaxial cable. George Brown on this aspect of the tests.

"AT&T provided coaxial cables between New York and Washington as well as to other cities. These cables were designated L-1 and could transmit frequencies from 0 to 2.7 megacycles while signals above 2.7 megacycles were attenuated rather severely, even black and white pictures had a loss of detail. The FCC required that color pictures created by the three competitors generated in Washington be sent to New York City, turned around and returned to Washington for display. The CBS 405 line signals retained color information but the picture detail, already poor, was further degraded. But the RCA signals came through only in black and white, a fact triumphantly noted by CBS. We anticipated this because the RCA system had a color subcarrier at 3.6 megacycles and this was well into the higher loss region above the L-1's 2.7 megacycle upper frequency limit. We stoutly maintained that this was not a serious defect because AT&T was in the process of upgrading the L-1 cables with a newer, wider band system they called L-3 which would when completed solve our problem of inter city distribution."

Point one against RCA.

While CBS and RCA were the two combatants, a third firm known as CTI (Color Television, Inc.) from San Francisco was also an entrant. To keep the systems identifiable, the FCC was referring to them as follows. CBS - field sequential, CTI - line sequential, and RCA dot sequential.

The live broadcast tests were designed to illustrate the state of home reception using local stations WNBT (owned by NBC), and WTOP (a CBS affiliate owned by the Washington Post newspaper). When the FCC last visited color TV (March 1947) CBS was expecting to get the nod and did not. And because Sarnoff had promptly hired as a vice president of NBC then-FCC Chairman Charles Denny the perception that RCA "bought their way out" of the skirmish was often discussed within the trade. At that time, CBS and Goldmark in particular could not admit their system contained shortcomings which might have influenced the FCC's seven commissioners to vote "no" to the CBS petition. But there were flaws in the system of which four stood out. One was the requirement that all TV receivers equipped for color have a motor driven disc or narrow wheel which must be as a minimum 2.44 times the diameter of the TV screen it shrouded. The second was the "flicker problem" which was inherent in any field sequential system. The only solution here was to darken the room, reduce the contrast and brightness on the display and allow your eyes to adjust to the artificiality of sitting hunched over a tiny screen. Number three was the requirement for a 12 megacycle channel width, impossible at VHF and therefore CBS had been led to not only urge the FCC to approve color but the opening of a little explored UHF TV band simultaneously. Finally, the matter of compatibility. When CBS transmitted a color program, the entire universe of black and white TV sets went dark (or displayed 16 gyrating miniature images that danced across the screen as if a chorus line).

RCA's 1947 effort was even less mature and RCA had to admit the quality of CBS color was superior. Between March 1947 and September 1949, CBS's Goldmark had made a few mathematical changes to his system and refined some of the color imaging systems. But it was still a mechanical color wheel spinning in front of a black and white screen, it was still incompatible with the growing universe of black and white receivers and it still flickered. The only real improvement had been compression of the information into a standard (VHF or UHF) 6 megacycle channel width which if nothing else at least made it compatible with the FCC's channel allocations policies.

One might suppose that with the vast resources of RCA, in the interim 30 months RCA would have made significant progress with their own attempts to produce color.

Unfortunately for RCA, this was not true. In fact, virtually no RCA time nor money had been expended on perfecting color in that period. All attention had been focused on UHF - which RCA saw as a new market for hundreds of new TV stations (to be hopefully equipped by RCA) and millions of new TV receivers (which of course RCA also planned to manufacture and sell). And it was not until Goldmark popped back into their vision with his medical field color TV cameras that RCA even thought about color broadcasting again.

RCA knew their 1947 design requiring four separate transmitters and 12 megacycle bandwidth was no longer a viable answer; indeed, it never was, according to Brown. When word got out that Goldmark believed he had created a new technique to compress medium definition color into a standard 6 megacycle channel, the RCA think tank went to work on the problem. It was early 1949 and progress (as Brown described it), "was leisurely until we were told the FCC would hold hearings in September to consider not only UHF but color again."

What is of note here is that RCA, contrary to what Eugene Lyons wrote in "David Sarnoff," was not active in further color research during the 1947 - 1949 30 month period. Lyons wrote, "The rival companies had about 2 - 1/2 years for further research on their respective technologies. CBS by their own admission curtailed research while RCA stepped up its work in this field."

Brown's "and a part of which I was" paints a different picture. He writes that after CBS conducted a brief display of their technology through Washington's WTOP for John Hopkins Medical School (Baltimore), he found that Clarence Hansell, in charge of research at the RCA Rocky Point, Long Island facility was developing a spectrum shrinking "time-division multiplex" system which might be adapted to the color TV problem. Brown wrote, "Since the time division multiplex composite signal takes far less bandwidth than would be needed by the individual signals side by side, the result is a helpful saving in the frequency spectrum."

What RCA needed, if they believed CBS would attract FCC attention with their slightly-modified-from 1947 field sequential system, was a break through in saving megacycles. The last project, which did so poorly before the Commission in 1947 and had not been updated in the interim, required 12 megacycles of spectrum space holding four separate carriers.

"Hansell agreed that time division multiplex might be used for transmitting the three signals (red, blue and green)."

Faced with an FCC dictum centered around a September (1949) hearing date, Brown noted, "an emergency meeting was held at RCA Laboratories attended by a large group including David Sarnoff. The atmosphere was gloomy and the mass opinion seemed to be that RCA could only appear as an interested observer except for offering our evidence concerning cochannel interference and the (proposed TV channel) allocation plan."

Brown continued:

"The meeting was confusing and I do not recall the details but at some point I muttered loudly enough to be heard that we could have a color television signal on the air in Washington by September if we really wanted to do so. My rashness resulted in my staggering from the meeting with the instructions to get cracking and with the authority to guide the technical program not only at RCA Laboratories but also in NBC and the receiver and transmitter divisions at RCA."

What came out of this very focused effort was the basis for today's NTSC color television system. It was a 16 hour per day, 6 or 7 day per week effort by first dozens and then hundreds of RCA engineers and technicians, drawn from essentially every division of the company. Unfortunately it was not destined to work very well (and often not at all) during the first two months of the FCC hearings.

While CBS was displaying a slightly modified standard TV set with a pregnant pouch protruding from the front left hand side panel, RCA's display receivers measured 6 feet high, 6 feet deep and 31 inches wide for a modest 12 and then 16 inch display. Moreover, as the system progressed, it grew and by late in November would also include a two cubic foot "addendum box."

What RCA needed was a single color kinescope (picture) tube. What they had in the fall of 1949 were 16 inch tubes (which somehow had to be fitted in a vertical position inside the monster housing) and focused through an external set of lens onto a frosted glass screen. Each of the electronic-primary colors (red, blue, green) actually has its own "TV set" and the combined outputs of the trio was what people saw on a projection glass screen. CBS sets could be placed on a coffee table; RCA's required flooring capable of taking a dead weight of up to a ton!

As Brown succinctly wrote, "We fully realized that our apparatus was far from ideal to show off our system concepts."

But it had a catchy name: "A Six-Megacycle Compatible High-Definition Color Television System." The key word here was "compatible." Brown recalls how David Sarnoff was introduced to the new RCA phrase.

"We were in complete agreement that our objective should be a compatible high-definition color system contained in a conventional six megacycle channel. A pair of NBC vice presidents visited David Sarnoff to explain the meaning of compatibility and to tell him how to spell the word. Within a week, he became the champion of compatibility and within a year, assumed a proprietary interest."

The first public RCA demonstration. Variety Daily headlined: "RCA Lays Colored Egg." Newsweek observed, "RCA's three-tube electronic device shifted shades like a crazed Van Gough. It took the color on the wrestlers and spread it across the bodies and a gymnasium wall."

Brown himself would reflect, "The audience was so stunned by our audacity that little attention was given to our display of some phosphor lines which were supposed to illustrate the possibility of a single color kinescope (tube)."

The following day, October 11, Peter Goldmark took the witness stand and engaged in this exchange with FCC Commissioner Freida Hennock:

Commisioner Hennock. "I had asked you a question earlier, Dr Goldmark, and you said you would rather answer it after your testimony. Would you like to answer it now?"

Goldmark. "Would you mind repeating the question?"

Commissioner Hennock. "I asked you how long it would take to make field tests on the RCA system with regard to propagation and apparatus."

Goldmark. "Under the conditions, I don't think there should be a field test on the RCA system at all. I don't think the RCA system should be field tested because I don't think the field tests will improve the system fundamentally."

Commissioner Hennock. "Do you mean to say that nothing can improve the RCA system?"

Goldmark. "No, nothing, I think."

Commissioner Hennock. "And then you advocate that they drop the system now?"

Goldmark. "I certainly do."

Commissioner Hennock. "And not even go into field testing?

Goldmark. "Absolutely."

In fact the RCA demonstration was so poor that few could conceive the color displays being any less attractive. Brown blames the problem on a number of factors including a record heat wave, a lack of air conditioning for the equipment, too many hands adjusting too many dials and knobs, and too many self-appointed chiefs and not enough Indians. Brown at the end of

the initial demonstration found, "the reception so bad that I telephoned to the studio to verify that the transmission was still in color, and not black and white."

Nominally you might expect with so many hundreds of millions of dollars on the line, a blood bath would have followed. It did not. David Sarnoff reacted to Peter Goldmark's late testimony to Commissioner Hennock by hand writing a memo which was widely circulated to "his team." In it he said:

"The (Goldmark) testimony suggesting RCA should withdraw our system is the most unprofessional and ruthless statement I have ever seen made by anyone publicly about a competitor. I have every confidence that the scientists and engineers of the RCA will answer this baseless charge by the improvements which I have already seen since the first demonstration and which will be made during the coming months."

Your mother possibly advised you, "First impressions are the lasting ones." This was mid-October 1949 and the FCC color hearings would continue until mid-May 1950. In that period of time, RCA would not only correct the "crazed Van Gough images" reported by Newsweek but in the final chapter actually pull a technological rabbit from the hat. If they did these things, would this change the first impressions formed about RCA on October 10? Almost to a man (and woman), no.

All that CBS had to do from this point forward was sit still, be kind and courteous to the FCC questioners, and let nature take its course.

Brown was determined to make the system work as it once had, although only briefly before having to be shipped from Princeton to Washington. He knew instinctively that what he saw in Washington's "show 'n tell" was not the RCA system. Gremlins had snuck in someplace. RCA had committed itself to nearly a week of demonstrations: Day one for the FCC, following which any interested person with a "ticket" of admittance. When word spread about how bad the images were, the "ticket" became much sought after. Al Warren writing in "TV Digest" observed, "It is the hottest ticket in town." Almost nobody could believe the bad reports would be confirmed by an actual visit; could (the great) RCA have set itself up for such a massive blunder?

Brown began taking the system apart stage by stage. First, to combat the torrid heat that continued for most of the demonstration week cooking the huge metal cabinet enclosed receivers, they ran a small wire under a carpet from a test receiver to a chair in the middle of the second viewing row. There he stationed a full-time RCA engineer who sat as unobtrusively as possible fingering a potentiometer (control) which allowed him to "track the hue" or color purity range. As the receivers heated up and the pink on a man's face began to shift towards the green grass behind him, the engineer touched up the control.

Brown. "The crowds were so large that all of the chairs were occupied and many of our guests were left standing." Brown's immediate superior noticed the RCA engineer 'lounging' in a comfortable and valuable seat and demanded the man should be moved.

"I informed him that our hue control occupied that chair and he had to admit that the pictures looked much better - for a few minutes at a time they were even very good."

If RCA was having a bad time, CTI was in even worse shape. They elected to demonstrate their system using projection receivers and the results were so dim that even in a pitch black room the viewers had to guess what was on the screen. One specially annoying and totally unacceptable artefact appeared when the CTI system was shown on a black and white receiver. They claimed it was "compatible" (like RCA) but the line-sequential format signal refused to stay still on the black and white screen. Each line of video jumped up and down and danced from side to side. Brown apparently felt sorry for CTI in the midst of his own problems.

"I wondered why CTI persisted with this system (and demonstrations) in view of really horrible results." Perhaps the boys from San Francisco believed that if RCA could hang in there, they could too.

FCC Chairman Coy decided to bring the presentation aspect to a head and scheduled a late November "side by side demonstration" in which all three applicants were told they must be prepared to use the same video and audio scenes to transmit to their receiver (side by side with the competitor's receiver) the same image. CTI took this opportunity to bow down if not totally out; they would not participate in "side-by-sides."

The FCC arranged receiving location was "Temporary E Building" which had been temporary from World War 1. In three rooms: One equipped with side by side black and white receivers from RCA, DuMont and a CBS supplied (Bendix) black and white receiver amended with a Goldmark "converter." In two adjoining rooms, one each RCA, CBS color receivers and a DuMont black and white receiver. The WNBW studio was the location of the cameras - DuMont supplied a black and white which then fed via leased line to DuMont owned and operated WTTG, CBS had a color wheel adapted camera which went to CBS affiliate WTOP while NBC's elaborate tri-image-orthicon camera fed into the WNBW transmitter. Doubtless Washington area viewers were puzzled by the strange video simultaneously appearing on their three local channels.

Each side played their own trump card in this demonstration. Why DuMont's black and white was even included had been a mystery until it came time for their transmission sequence. It consisted of two men (one black, another white) boxing, followed by a choral group made up of a large number of black men outfitted in black tuxedos, black bow ties, gleaming white shirts with white carnations in their lapels. The DuMont subliminal message was, "color" would add very little if indeed anything to their two selected events.

CBS produced a "Woman's Program" with an auburn haired hostess. Well, she had auburn hair on rehearsal day and as RCA would be staffing each of its receivers with a "hue control engineer" who would make constant (as required) adjustments to the receivers during the telecasts, notes were passed from the WNBW studio to the Temporary-E engineers as to what colors to expect and therefore indirectly how to adjust the hue controls. But CBS pulled a fast one - on the day of the actual telecast, the same lady appeared with what George Brown described as, "a ghastly shade of pink hair." Naturally the RCA engineers at the receiving site thought their TV sets had gone whacko and immediately began twisting the hue control to compensate. When they somehow managed to turn ghastly pink hair into auburn, the lady had a green face. The FCC personnel watching this without knowledge of the subterfuge dismissed the entire RCA display as, "RCA is out of adjustment - again."

RCA was not above some minor shots at the enemy. One of their live acts was a champion lady baton twirler. Brown figured that the rapidly gyrating baton would be moving so fast that on the CBS system it would appear as a broken series of disorganised lines - his way of illustrating the low definition aspect of the CBS system. It did as he forecast but nobody from the FCC seemed to even notice the ragged display.

The FCC sessions were now almost two months on with virtually no off. Brown reflected on the Temporary E demonstrations in this way:

"The performance of the RCA systems was not too bad during these comparative demonstrations. While our color fidelity left something to be desired, the colors were no longer unstable. The detail in the picture was good and compatibility (with standard black and white receivers) was proven. Our bulky triniscope receivers were quite properly ridiculed by CBS and many others. Our color cameras were certainly more complicated than the CBS cameras. But our confidence was returning to high again. We felt our basic system principles had been demonstrated, although to a hostile audience."

If RCA "confidence was returning to high" CBS was over the moon. Capitalising on the yet-to-end color side shows, CBS mounted their own WTOP weekday demonstration which was their way of keeping color on everyone's mind and the pressure on RCA and the FCC.

Writing in Televiser Magazine for October 1950, CBS-TV Director Fred Rickey describes how his network opened their color TV demonstration period (20 minutes per day, typical) during January and February 1950:

"Our regular demonstration broadcast had a very simple opening. All you saw was a glass bowl of water into which we dropped a red rose while the network announcer read, 'Pure and clear as fresh water, rich and colorful as the flower of the garden is the world in which we live'. This close-up of a red rose falling into crystal clear water never failed to bring 'oh's' and 'ah's' from the hundreds of spectators who had obtained their tickets to watch CBS COLOR Television at the Walker Building in Washington."

Seemingly, following the late November side-by-side comparison testing, which followed earlier testing using coaxial cable and off-air antennas, the evidence gathering would be complete. Not quite. For intermixed in the entire hearing were two more elements.

RCA continued to maintain they had an evolving system which was "not yet complete." And they needed more time - months perhaps, not years - to reach a plateau of performance with their compatible system. This possibility played on the minds of official Washington for even the FCC had to admit that a "compatible system" was preferable to a system which antiquated the existing universe of black and white receivers. The second element was more technically mundane. The FCC had now become convinced they had to dispose of two problems simultaneously - creating more channels for television and selecting a suitable color system. Only then could "the new station freeze" be lifted.

CBS hoped to convince the commission that conversion or adaptation of existing black and white receivers, to either black and white reception of the non-NTSC CBS color system, or a full conversion with the addition of a spinning color wheel, was an acceptable interim solution for the growing universe of TV receivers.

Brown wrote:

"CBS had introduced testimony to the effect that black and white receivers could be easily adapted to receive the field-sequential signal in black and white by adding a few components. Peter Goldmark had declared that this modification was cheap and easy to bring about and in turn CBS had persuaded David Crogan, President of Air King Products Company (a TV set manufacturer), to testify to his faith in such a conversion.

"Then suddenly the FCC joined the CBS team as advocates. E.W. Chapin, Chief of the FCC Laboratory Division, worked out circuitry to make possible the reception in black and white of a field sequential signal. This device was soon referred to as a 'Chapin' converter by FCC Chairman Wayne Coy as he proudly proclaimed this invention. So now we were faced with a 'judge giving testimony'.

"Chapin testified concerning his converter and entered as Exhibit 390 an FCC report titled, 'Modifications of Existing black and white receivers to receive color television'. The fallacy lay in the means of accomplishment due to the sheer number of black and white receivers already in the hands of the public; almost six million in the spring of 1950.

"While Chapin was testifying I did some calculations on a scrap of paper. I assumed that by taking heroic measures, the RCA Service company might be able to assign 100 teams of technicians to the task of converting the existing receivers. By allowing four conversions each day for each team, one finds sixty years would be expended in the task. But this situation becomes even more absurd for long before 1950 passed, ten million sets were in use and not many years past that point, 50 million."

Any "evidence" entered in testimony by one side promptly attracted a rebuttal or counter evidence from the other. CBS wanted to enlarge the importance of their pluses, minimise the importance of their minuses. And so did RCA.

RCA's October 1949 show-off system had been conceived, designed, tested and duplicated in sufficient quantity to deal with the Washington hearing in between April and September. It borrowed only vaguely from the 1947 system, had achieved a modicum of technical success in compressing all of the required color plus black and white and sound information into a 6 megacycle channel width using technology that was largely totally new. In the rush to make it work, there had been some shortcuts which Brown now regretted in October.

It was a small but pivotal technical point. Using the Clarence Hansell time division multiplex technology which had been pioneered for shortwave message circuits, the Brown directed development team head quartered in Princeton made some quick decisions. The key to TDM was a "color subcarrier" which contained most of the color material instruction. The subcarrier had to be "hidden" within the channel width, at a location where it would not interfere with the basic black and white (picture detail) information. Someone at RCA, Brown does not disclose who, selected 3.8 megacycles because, "it would keep the visibility of the subcarrier as viewed on a black and white receiver at a minimum." His original calculations had suggested a frequency just below 3.6 mc.

Following the initial RCA October demonstrations (Variety: "RCA lays colored egg"), something caused Brown to ponder whether their reception instability might somehow be related to the 3.8 megacycle subcarrier. On a hunch, "I caused the subcarrier to be lowered to (my originally suggested) 3.6 megacycles which immediately produced better pictures. Because of this change, we were much better on November 21 and 22 than on October 10."

There was other evidence that RCA was making regular progress on the quality of their reception. While many of the RCA technical team were camped out in Washington, those remaining at Princeton were pursuing additional potential improvements. One effort, led by Al Bedford, was a modification to the color signal's synchronization stream. Bedford added "a burst on the back porch of the synchronizing pulse" which tests indicated suddenly resulted in a far more stable image. Over the January period Brown and team modified the Washington transmitter by adding the back porch burst and then the receivers which would interpret the new pulse and convey it to the receiver's color stability circuits. About which Brown wrote:

"A demonstration to the technical press and to some of our friendly enemies was staged on January 21. Since the FCC was in (holiday) recess, only a few of the FCC staff attended, unofficially. The results were even better than I had anticipated and not a knob was twiddled. I realized we have taken a giant step and others acknowledged this.

"Television Digest for January 21 ignored the official RCA press release and stated the case more succinctly: 'RCA solves its major color problem by transmitting 3.6 mc bursts for each line, every 63 microseconds. Dr George Brown said, 'Look - no hands'."

The FCC was back in business in February and on the 23rd yet another round of demonstrations was scheduled for the FCC Laboratory at Laurel, Maryland. One of the stated purposes of this round of testing was to allow the Commissioners to focus on the question of incompatibility. Seemingly everyone involved by now understood that when CBS transmitted in color, standard black and white receivers simply quit playing. Seemingly.

Commissioner Robert Jones showed his shallowness by explaining to a bewildered crowd that when CBS transmitted in color, "the pictures on a black and white set were 'a little fuzzy'." He was someplace between amazed and dumbfounded to confess that after months of hearings, he still had not grasped the significance of incompatibility.

Brown's reflections on the 'quality' of the commissioners would become legendary and he wrote about Jones:

"Robert Jones, a lawyer, was loud and bumptious and less than bright. He was prone to asking stupid questions and not listening to answers which were not to his liking."

Did Jones' new knowledge change his position on CBS? Of course not. Did the February 23 testing results change any commissioner's mind about anything? Brown:

"While the performance of the RCA receivers was far better than any previous appearance, the commissioners did little note nor long remember what transpired and they made no comments that day or later. The whole affair was an exercise in futility."

Intermixed with the demonstrations that seemed to be reborn every month to six weeks, highly technical and complex testimony went into the record from RCA, DuMont and others. This involved the FCC's concerns that if they adopted a color system - any color system - how would this impact cochannel and adjacent channel reception? The freeze instituted in September 1948 was to be six months after which the Commission was expected to begin anew accepting applications for new TV stations. When the freeze began, 37 TV stations were authorised to operate, 110 total had been granted either a license to operate or a construction permit to build, and 310 additional applications were sitting at Commission "in baskets." Starting in early 1949, the commission staff had created a number of "revised allocation tables" moving channel numbers around on a large wall map trying to find city assignments which would create the maximum number of viewable channels for the largest number of people. Their effort was hampered by political and threatened retaliatory antagonists. Senators and Congressmen from states and regions already with TV feared that if channel numbers were reassigned to new communities, their constituents could lose one or more existing or promised channels of service. Tugging on the opposite ear were other elected members of Congress who saw in the original and then proposed channel assignment tables their own folks being left with too few (or no) TV channels. Television had turned into a political football and the business folks whom Congress depended upon most for re-election - the owners of radio stations and newspapers who were already or who wanted to be TV operators - placed intense, never ending pressure on the elected representatives. This in turn was transmitted to the FCC hierarchy in the form of veiled threats covering future appropriations for the FCC being reduced. Even commissioner Robert Jones understood that if FCC funding was cut in half by a frustrated Congress responding to constituent pressure, the agency would be in deep trouble.

Cochannel and adjacent channel interference, using color transmissions rather than black and white, was a technical issue to be investigated. The fear was that somehow, some way color might change the relationship between stations on the same or adjacent channels and cause more interference between stations than black and white created.

Cochannel interference could be reduced but not eliminated by any method known to man or RCA. The folks from Princeton tried. Brown wrote,

"By the end of 1947, NBC had two television transmitters in operation on channel 4; WNBT in New York City and WNBW in Washington. Immediately after WNBW turned on, we began to observe interference in the picture when we were looking at WNBT. The interference took the form of horizontal black bars that moved rapidly up or downward in the picture and were soon called 'venetian blinds' because of the effect on the screen.

"Soon similar interference was observed in other parts of the country where two or more stations were operating on the same channel. The FCC, in making channel assignments, had permitted cochannel stations to be located too close to each other."

RCA's first attempt to correct the problem was based upon good science which was unfortunately two or three decades ahead of technology to properly implement. They erected

suitable high gain antennas at Princeton to track the exact operating frequency of WNBW in Washington. Then using a telephone line, this information was relayed to WNBT where the carrier frequency was tweaked up or down by a few cycles to create exact synchronisation between the two signals.

What this did was eliminate the image degrading "venetian blind" lines on the screen. But when RCA demonstrated the system to FCC engineers at Princeton, they neglected to explain that someone had to sit full time in Princeton and someone else full-time in New York City to measure the "offset difference" between the two signals and then tweak the WNBT carrier to compensate.

But RCA was hopeful this could be automated knowing that while they might tolerate the requirement for two full time personnel to constantly monitor and adjust the system, other stations across the country were far less likely to oblige. A Western Union relay site located at Brandywine, Delaware was identified as being precisely half way (103 miles) from each transmitter and here RCA established a complex off-air receiving system to full-time monitor the pair of channel 4 signals. But both signals were weak at the site, so weak that when a car drove by or a farmer operated his tractor within a few miles of the site, noise pollution caused the automatic sensing equipment developed to go haywire. The effect was this. When both stations were received with "clean" signals, the monitoring equipment performed very well and WNBT by remote control chased the WNBW frequency around to keep both stations in perfect frequency synchronization. But if one or both signals were lost in any kind of interference, the automatic correction system went into high speed overdrive searching for the missing information. As a result, instructions to WNBT's transmitter were lost - it was flying without instruction and erratically jumped about in operating frequency hoping to find a "lock." In the field, the cochannel signals flashed from perfect synchronization to widely varying venetian blind combinations which turned out to be a far worse fix than simply putting up with stable if annoying lines on the picture. RCA simply locked the door at Brandywine and retreated to Princeton.

Fortunately Alda Bedford at Princeton was also been thinking about the problem and had come to the conclusion that if the two same or cochannel transmitters could not be reliably synchronized to the exact same frequency, perhaps there was some combination of frequencies where the venetian blind effect was more tolerable to viewers. The horizontal lines could be counted on the screen and then this "count" used to calculate the actual frequency separation between two stations who were nominally supposed to be transmitting on the same exact frequency. However it was beyond the TV transmitter designs of that era to maintain very closely their "exact frequency" so as two stations drifted around within the assigned TV channel, the slight difference in each operating frequency turned into varying numbers of black bars on the screen.

RCA's Bedford thought he found two regions which he called "frequency offset" where the visual effect of the venetian blinds was reduced, if not totally eliminated. One of these requited two same-channel stations to operate with a carrier frequency difference of 7,875 cycles (7.875 kilocycles) which importantly was precisely half of the line scanning frequency for black and white television; 15,750 lines per second. Another was 10,500 cycles (10.5 kilocycles). RCA proposed to several channel 4 stations around new York City that they adopt this technique as a test. WRGB in Schnectady and WGAL in Lancaster were moved +10.5 kilocycles while WBZ in Boston and WNBW in Washington were moved -10.5 kilocycles.

All of which explains why the FCC was sensitive that by switching to color (*any* color system) the delicate balance between stations operating on the same channel might be upset. What RCA and RCA alone submitted to the FCC on this potentially serious flaw was

assembled by Gordon Fredendall and fed to George Brown who created a voluminous written report for submission.

Brown noted:

"I submitted the study to the FCC on January 19, 1950 showing that the results for the color systems were the same as for black and white. At that point the commissioners could have lifted the ban on new-station construction if they had understood the significance of my presentation. There was no better or further data available when the ban was finally removed in April 1952."

Brown's notation, while subtle, is illuminating. After January 1950, there was no technical reason why the FCC should continue to deny new applications for additional TV stations, save their own inability to come to grips with a new channel allocation scheme. But this was real, although it was politically based, not technical in origin. Between mid 1949 and April 1952, several dozen channel assignment tables (a table was a list of cities followed by one or more channel numbers to be assigned for operation in that city) were created within the bowels of the commission. The constantly reworked tables were a fruitless, impossible effort to complete because each time a channel was taken away from one city and assigned to another, a Congressman complained. Influential newspaper publishers and radio station owners were quick to contact their own representatives in the House and Senate and they in turn were on the telephone to Chairman Coy or a subordinate. The "plums" of this exercise ultimately would be VHF channels, low band or channels 2 - 6 preferably because they travelled best through the atmosphere, in the greatest possible quantity. New York and Los Angeles had already been assigned seven VHF channels each while secondary population centers such as Peoria or Fresno had none.

By March 1950, most of the industry participants in the FCC's mandated hearing were tiring of the repetitive nature of the questions, the growing stacks of written testimony which almost everyone believed would never be read by the FCC - and if read, little comprehended - and increasingly every indication that "based upon first impressions" CBS was either a shoe-in, or, in any event, RCA would hear "no."

RCA needed one or two rabbits if NBC's planned peacock was ever going to greet TV viewers. One would be technical, the other an attempt to be persuasive. Brown put the technical innovation in these words.

"The entire success of our case before the FCC rested on our ability to show the feasibility of a single color picture tube."

Timing was everything. From the "RCA lays color egg" headline of Variety early in October to March's vastly improved RCA color performance, the boys from Princeton were closing the gap on CBS. They had compatibility, CBS did not. They had resolution at least the equal of CBS and every promise it would improve. They were "all electronic" and CBS required a motor driven colored wheel spun in front of both the camera pickup tube and the receiver cathode ray tube. What they did not have was a "believable" receiver.

On February 24, 1947 RCA's Alfred Schroeder filed with the US Patent office a design for a new type of television picture tube. His paper design (one had not been built) tube had a multiplicity of tiny dots of light emitting phosphors arranged on a glass surface with the dots in a triad of red, blue and green. In the neck of the tube, in place of the single electron beam in a black and white picture tube, a triad of beams which the circuitry would direct through a metallic grid or gate in such a way that only one beam struck the green dots, only one the red, and only one the blue.

RCA's 1949 color system had pressed into service 12 inch (later 16 inch) diameter triniscope tubes, a trio for each receiver, and this created the monster metal cabinet measuring 6 feet high, 6 feet deep and 31 inches wide which nobody - not even RCA - could pretend was

the future of consumer TV sets. But this nearly one ton monster appliance got RCA from "laying an egg" to the final quarter of the game.

While half of Princeton's staff was in and out of Washington from September to March, a special crew with unique talents had been working six and seven day weeks quite out of public view to turn Schroeder's patent application into one or more working single tube color imaging systems. Part of the RCA strategy was to stretch the hearings until Princeton could create a suitable picture tube.

Shortly after October 1 (1949) five separate teams began work on the color picture tube. Brown described it:

"The teams began sixteen hour days just as our system teams had done in the previous summer in preparation for the FCC hearings. New techniques were developed and new inventions came about at critical moments. By early February (1950) a decision was made to prepare for a demonstration in Washington with complete receivers. Two of the more promising designs of shadow-mask picture tubes were constructed, one design with three electron beams and one with a single switched beam.

"On March 23, Commissioners Jones, Sterling and Webster with FCC staff and Colorado Senator Johnson had a first peek at RCA's tricolor tube. The color receivers were standard sixteen-inch table models adapted for color. One receiver had the three-gun, three-beam color kinescopes and the other a single-beam switched color kinescope. Then RCA shot the works at a press showing on March 29 where David Sarnoff completely dismissed the CBS system and crowed our success. The official demonstration for the FCC record took place April 6, at which time we also demonstrated a newly RCA developed method of transmitting the RCA color signal over the narrow-band L-1 cable from Washington to New York and back."

Logic early in April might proclaim CBS "dead." RCA had a table model receiver that fit into any living room, a transmission system which was fully compatible with the rapidly increasing universe of black and white sets, and just as an aside, a new modification for AT&T L-1 coaxial cables that allowed color to be sent from city to city.

CBS had a muted response. Brown's recollections of how they reacted:

"CBS statements alternated between saying the shadow mask tricolor kinescope could not really be made to work satisfactorily and saying that when it was perfected it would be useful for the CBS system."

In fact the rushed-development tube was not perfect; yet. It would be 1953 before this particular tube design was refined to a point where it was economical to build in quantity and not "fiddly" to align and maintain. There was a sublime level of poetic justice in who made the final breakthrough, and where. Two engineers named Norman Lyler and W.E. Rowe employed not by RCA but rather by a Newburyport, Massachusetts newcomer in picture tube technology called CBS-Hytron (a division of the Columbia Broadcasting System). But that is pushing our time envelope into the future - still ahead, the vote for an approved color system at the FCC.

The hearings were now winding down. Goldmark took the witness stand one last time and delivered his parting shots. Those who heard them read "sour grapes" and "concern" that RCA had wrestled defeat into the jaws of sure CBS victory.

"RCA's tricolor kinescope has grave registration problems (unable to make each color pure without impingement from other nearby phosphor dots) and it will probably be that way forever. The resolution of the image is degraded in color and black and white while black and white pictures from color transmissions are always fuzzy. The possibility of the RCA system ever becoming a practical system for home use is extremely doubtful."

In one final day of testimony Dr Thomas T Goldsmith requested time to demonstrate a 21 inch receiver which his DuMont lab had modified with a CBS sequential field color wheel

system. Having never witnessed a color image larger than 16 inches and knowing DuMont's reputation for high quality video skills, FCC Chairman Wayne Coy agreed. Dutifully, DuMont engineers struggled to bring the huge appliance into the FCC hearing room. Instantly Coy must have known he erred in approving. The TV set's 21 inch screen had a nearly-five-foot side mounted attachment - the color wheel. One FCC observer thought it looked like a not-too-miniature "paddle wheel boat imported off the Mississippi." To operate the set, its sizeable motor and the color wheel nearly as tall as the Chairman, DuMont engineers ran a heavy duty extension cord to a primary electrical outlet. At the appointed moment the set was turned on, the motor's gigantic wheel began to whirr and then the hearing Commerce Building auditorium was plunged into darkness. The current load of the motor plus the receiver had blown the fuse for the room. DuMont - the corporation - was an independent voice throughout the hearings, neither a fan of CBS nor a foe to RCA. They were frequently outraged when the lack of intelligence exhibited by the seven commissioners dropped below a threshold and they frequently created a situation which they hoped would force the commissioners to focus on what DuMont termed, "core issues." In the case of the large spinning CBS disc, the FCC's incomplete comprehension of basic physics and engineering was, DuMont thought, crying out to be a "core issue." Engineers could have explained that the size of the electric motor required to rotate the disc at 1200 or more revolutions per minute rises neatly as the fifth power of the diameter. Simultaneously, the control circuitry for maintaining synchronism becomes vastly more complex for more massive drives and discs. A 19" picture tube, for example, required a ten horsepower motor. Moreover, Dr DuMont had directed his staff to build - for photographic display - a 30" cathode ray tube behind a nine foot (!) wheel believing that if enough people saw such a monster the "lunacy of the CBS system" would be self-evident. Fortunately, the "monster" was never transported to and plugged in at the FCC.

Coy's reaction to the blown fuse was livid, forcibly reminding him of the real world problems attached to the CBS color wheel system, which he preferred to gloss over. His anger caused an exchange of words with Goldsmith ending with the Washington equivalent of, "You will never work in this town again!"

So on May 26, 1950, 8 months to the day and 62 actual hearing dates after it started, the gavel closing the longest FCC hearing in history banged. There were 9,717 pages of testimony, 53 witnesses, and 265 exhibits. Apparently not even CBS expected CBS to get the nod and Brown reports his many industry cohorts were referring to the final RCA color product demonstrated as "Harvey" after the rabbit that jumped out of a hat.

It was a bittersweet summer. Brown's fatigued color crew had major work still to be done to ready the RCA system for actual commercial use, and there was new input from research firm Hazeltine Labs which would in the final analysis make contributions to the ultimate RCA color system standard.

The maverick inventor, Goldmark, in his tome vaults from October 1949's demonstrations to September 1, 1950 in barely one page. His essence was, "CBS's system worked, CTI and RCA could not make theirs work," all said in less than 300 words.

The FCC did what almost nobody expected them to do. They approved the CBS system on September 1, 1950 with a couple of minor and bendable conditions attached. Goldmark recounts:

"CBS won what was the first major prize in the color fight, a commercial license to proceed with color TV and in October, 1950, Paley, the impatient anti technologist, found himself with an exclusive franchise in a device made by the latest technological research. November 20 was set as the date for debut of CBS color."

Some might read into this that even 33 years after the 'victory', when Goldmark wrote the above sentence, he remained self- dillusional.

George Brown recalls meeting a CBS vice president at a Washington function after the FCC announcement. George says he congratulated the man and received this response:

"Thanks a lot. A Pyretic victory if there ever was one. Another victory like this could ruin us."

The FCC decision, which understandably Brown described as "a long and poorly phrased document," set down two conditions to be met before CBS could begin exercising its "exclusive franchise" for color TV.

Condition number one: The industry was given 90 days to produce and demonstrate a system superior to that of CBS and failing that, CBS was the choice. There was no guideline as to what would constitute "superior performance" and as virtually the entire industry anticipated and expected RCA to be selected prior to the FCC's September 1 announcement, it was apparent that whatever system as might be offered within 90 days, could not be spelt 'RCA'.

Condition number two: And the corker aimed squarely at the folks who manufactured TV sets. They were granted 28 days (to September 29) to agree that future TV sets "would include on all black and white receivers a switch (manual or automatic) and other needed circuitry so the receiver could receive conventional black and white broadcasts or receive in black and white any broadcasts of color by means of the CBS field-sequential system." If assurances were not received from a sufficient number of manufacturers, a final decision adopting CBS color standards would be issued forthwith.

Think about this. Agree to include such a switching system and the FCC would not adopt the CBS system. Do not agree and they would declare the manufacturers uncooperative and reconfirm the selection of CBS. Agreement meant a market that was capable of receiving CBS color, even if in black and white, steadily growing in size. Disagreement meant CBS could broadcast all the color it wished but there would be no-one out there watching, even in black and white. Agreement meant no "exclusive franchise" for CBS color (no FCC mandate) but CBS would be free to broadcast in its system if it wished and the marketplace would in theory sort the mess out. Predictably, the TV set manufacturers and RCA exploded with indignation.

George Brown:

"During September, many receiver manufacturers informed the FCC of the problems involved in providing sets which conformed to the standards, particularly with respect to cost and time to study the performance factors. Neither the commission nor its staff had experience in design and manufacture of television receivers while Goldmark was also sublimely ignorant of the problems as he egged on the commissioners."

Goldmark for whatever designer qualities he might have possessed was not a receiver designer and although he believed "a handful of parts and a few minutes of time" was involved in modifying a receiver for black and white reception of CBS sequential color, his actual experience here was non-existent.

TV set makers, many of which with names you will not recognise today, lined up for and against the CBS color plan. The run down.

Firms that said they would build 'adapters' (to allow existing black and white sets to receive CBS color transmissions) and 'converters' (to modify an existing black and white set to receive CBS color in color - including the addition of a spinning disc filter): Celomat Corp., The Hallicrafters Company, Muntz, Television Equipment Company and Tele-Tone.

Manufacturers who said they would build CBS standard color receivers: Emerson Radio and Phonograph, Philco.

Manufacturers who said they would never build CBS color receivers: Admiral, DuMont Labs, and of course RCA.

By December 1950, Emerson had changed its corporate position - they would not build CBS color receivers (leaving only Admiral as a major name supplier planning to do so). RCA of course had a battle plan which it put into motion October 4 by filing a formal petition asking the FCC to withhold a decision until June 30, 1951. The FCC responded quickly, October 10, denying the RCA petition and issued its "Second Report on Color Television Issues" which modified the original First Report to the extent that as of November 20, CBS was (as Peter Goldmark termed it) the "exclusive franchisee" for color television in the United States. Further, CBS was told it could begin commercial color-casting on that date.

George Brown in perhaps a mellow moment writes, "David Sarnoff was furious and instructed his legal staff to get busy. The result, which I still believe to have been unnecessary and ill advised, was a suit filed by RCA on October 17 in the United States District Court of Chicago asking the court to set aside the order. This court in November 15 issued a (temporary) restraining order (TRO) to prevent the start of commercial broadcasting of color until the court could review the situation. On December 22 this same court issued its statement which upheld the action of the FCC (the decision favoring CBS) but continued the restraining order pending a Supreme Court review."

RCA was not alone. A similar, but not as expansive nor as well funded, case had been filed in New York City by The Pilot Radio Corporation, essentially seeking the same end result as RCA; setting aside the FCC selection of field-sequential color as the "franchise selection." Pilot manufactured a line of home TV receivers including a 3" black and white set which was very popular at $99.95.

A closer retelling of Sarnoff's reaction is found in Eugene Lyon's "David Sarnoff" biography.

"The blow was more painfully abrasive than he could acknowledge publicly. He had taken a beating - not to familiar an experience in this case. Under his outward composure was the knowledge that the setback must be explained to shareholders and that his board of directors must be imbued with his own confidence in ultimate vindication. This would not be simple. Already huge sums had been siphoned off from profits and dividends into color. Thus far they had brought only the privilege of pouring in more and more, with no end in sight."

Sarnoff ordered a crash effort to complete the commercialisation of the "RCA color system"; seven days a week, eighteen hours a day. By means of well publicized periodic demonstrations of all-electronic color progress, he would in effect appeal to public and industry opinion and thus place the FCC on the defensive.

RCA asked the Chicago court to, "enjoining, set aside, annul and suspend the Commission's order." That the FCC decision, as written and released, was flawed in its citations is without question. For example, the FCC cited their reaction to "viewing demonstrations held in October and November 1949," ignoring the significant progress exhibited during March and April demonstrations featuring the single kinescope display system. "First impressions" were indeed the lasting impressions when commission personnel sat down to draft their order.

RCA's stepped up public demonstrations, concurrent with their court activity and aggressive solicitation of support from the television industry, drawing positive responses that worked its way into the public press. The New York Times for December 10 wrote:

"Last week's demonstration of the improved color system of the Radio Corporation of America materially changes the whole outlook on the dispute over video in natural hues. The success of the demonstration, which is a feather in the cap of Brigadier General Sarnoff, puts the Federal Communications Commission on a spot which appears certain to become

controversial and embarrassing. Technically, it ultimately may be proved that the FCC committed a classic 'boner.'"

George Brown in describing the demeanor of the seven commissioners had this to say about Chairman Wayne Coy:

"Wayne Coy had come from the Washington Post newspaper organisation. He was reasonably intelligent, very opinionated, heavily biased in favor of CBS, antagonistic to industry, and, short tempered."

The Washington Post owned television station WTOP, channel 9 in Washington, a CBS affiliate. That may have never been a factor in Coy's handling of the color hearing but there were times when it simply "looked bad" that he had recent ties with the very network of whom he was passing judgement.

Dr Goldsmith of DuMont had felt this "short temper" when his 21 inch color adapted TV set cloaked the hearing room in darkness. If "short tempered" and "very opinionated" described the man accurately, then Eugene Lyons in "David Sarnoff" may have been on mark with the following:

"Stung by growing criticism, the FCC chairman Wayne Coy, took to the hustings to defend the ruling on color. He identified himself completely with the CBS cause, making speeches and haranguing the press. Its proprietary aside, this conduct was scarcely wise. Should it develop that the Commission had, indeed, pulled a 'boner,' he was merely making it more osseous."

The December 20 Chicago court decision upholding the FCC's decision raised a new array of legal questions. What seemed to Sarnoff to be unfair was the court's reliance on "the doctrine of agency expertise." His discomfort was re-enforced when on May 28, 1951 the United States Supreme Court sustained the Chicago Federal Court decision. The way was now totally clear for CBS to become the "exclusive franchisee of color television in the United States."

How CBS reacted becomes the final chapter in our story. On May 28, the day of the Supreme Court's decision vindicating the FCC action, CBS went on the air in New York, Boston, and Washington with a one hour field sequential program hosted by the red headed Arthur Godfrey. They repeated this one hour exercise from 4 to 5PM for several weeks, oblivious to the fact that when they did so every black and white TV set tuned to CBS went to "hash" for pictures. Within a week, the advertising sales people at the network reported the programming that followed the hour color-cast was experiencing a 50% or greater drop in audience from pre-color exhibitions. The viewers, it seems, were tuning out of CBS when the image when wacky and not returning for several hours. Lost audience meant lost revenues and now CBS was paying a daily price for its commitment to new technology.

More concerning was that a few hundred adapters aside, the public was not responding to the opportunity to convert their black and white sets for receiving CBS color - in black and white. CBS could see this coming of course - when Emerson re-evaluated their original decision to offer CBS color receivers, and Admiral waffled on "when" they would be available, CBS was in a tight spot. They had a "franchise" all right but imagine being a McDonald's franchisee and having no meat nor potatoes to sell!

Returning to Goldmark, he claims no originality of thought when Paley directed CBS to become a manufacturer of TV sets and tubes.

"I think Paley came away from the (Supreme Court) decision a transformed man. He had just trumped the General in the place it hurt - the prestige belt. I always felt that despite his jet set executive veneer, Paley secretly admired Sarnoff's propensity for empire building. The first glimpses of the new Paley as a manufacturer came one day when I was asked to look at the technical expertise of a Brooklyn electronic-tube manufacturer, Hytron Radio and

Electronics Corp, and its set manufacturing subsidiary, Air King Products Co, which was making (radio and TV) sets for Sears Roebuck and Montgomery Ward." That day would have come as early as November 1950 but there is no record of actually when it began.

"Paley was hypnotized with Air King. So was Stanton. Both men personally travelled to Brooklyn in chauffer-driven limousines and became involved like goggle-eyed kids with the styling and coloring of the sets and what ornaments and knobs to use."

CBS used corporate stock to take-over Hytron and Air King; the Coffin Brothers who owned the firm became instant multimillionaires and were appointed to the CBS Board of Directors. Dave Cogan, President of Air King and Frank Stanton became inseparable. Paley hired Zenith merchandiser professional Henry Bonfig making him the head of the newly named "CBS Columbia Manufacturing Group."

A Hytron employee named Sava Jacobson, as chief engineer for Air King, provides us with valuable insider's insight as to what happened when CBS arrived on the scene. Neither RCA's Brown nor Peter Goldmark seem to have had intimate access to the ill-fated attempt by CBS Columbia to design, manufacture and distribute field sequential color TV sets. Goldmark tried to use the acquisition to Air-King + Hytron to create a CBS "Research and Development Lab" similar to that operated by his nemesis RCA at Princeton. Paley's answer was short and unbendable. "We are in show business, not manufacturing!"

Jacobson was first introduced to CBS in November 1950. This was at a time when RCA was asking a Chicago court to overturn the FCC's decision, Emerson had not yet changed their mind deciding to not build field sequential color sets so at that point they remained a "possible source" of CBS color receivers. Jacobson recalls visits from Goldmark, Paley and Stanton during that month and being asked to look at some basic receiver adaptations which could be included in the Air King TV line to make the sets "compatible" with receiving CBS color casts in at least black and white. None of this runs contrary to what we have previously learned for CBS had in fact coerced Dave Cogan of Air King to testify before the FCC on November 21 (1949) about the "ease with which existing black and white receivers could be so adapted."

Jacobson was there, at Air-King, and he took notes. We have every confidence in his reflections. A number of new names appear in his reflections and each played a part in the CBS-Hytron debacle.

"Air-King was wildly profitable. During World War 2 it operated on cost-plus military contracts and continued to do so during my tenure. As Chief Engineer, I was on the third executive level and yet my Christmas Bonus often equalled 20% of my yearly pay and I received regular raises."

A new name. Sears, as in Sears-Roebuck with headquarters in Chicago. It would be largely intramural activity practiced by Sears personnel which would bury the CBS Columbia field sequential color project.

"The arrangement with Sears was (also) on a cost-plus basis" and at the end of each fiscal year Air-King as a supplier of Silvertone branded radio and TV products was subjected to an audit to define the "cost" side of the equation.

Any good mystery deserves a plot and Jacobson provides a humdinger. The FCC on September 1, 1950, in announcing the conditional franchise award to CBS, demanded proof from the receiver industry that if CBS was certified, receivers would become available. Two "reputable" manufacturers had to step forward and show a willingness to produce field sequential TV sets before CBS could be declared "the winner." Both Emerson and Admiral initially did just this, although shortly Emerson would reconsider and Admiral would simply fail to make good on its public statement. An employee at Sears in Chicago, an assistant buyer

with dreams of sudden riches and personal advancement, with or without some outside help, had a plan.

Sears Division 57, the group that bought radio and TV sets with Silvertone on the case or cabinet, had first introduced a "Silvertone" TV set (a 26 pound 7" screen portable, catalog 57 km 9117 at $149.95) in the Fall 1949 catalog. In Spring 1950, Sears' catalogs displayed this model, and added a 12 - 1/2 inch table and console model as well. By the fall of 1950, a 16 inch console appeared. Sears neither designed nor manufactured radio (or television) sets at that time. Their two primary outside contractors were Tele-Tone and Air-King, both located in New York City. Tele-Tone's President was a man named Sol Gross, the nephew of Dorman Israel, the head of Emerson Radio. It was Tele-Tone that manufactured the initial Sears 7" TV set. There was no direct overt connection between Tele-Tone and Air-King although the New York City world of radio and TV manufacturing was "family" in more ways than one. Sava Jacobson relates, "In 1947 I was hired to develop a TV engineering staff for Air-King, I had developed my own version of the 7" electrostatic (focused) receiver while working at a firm similarly named (Tele-King) for portions of New York City where the wall voltage outlets were still DC (direct current). Standard AC voltage TV sets could not be used in such areas so with a 110 volt DC model we had a narrow but enthusiastic 'niche market'."

From 1949 onward until a Frank Stanton dictum in 1953, Tele-Tone and Air-King were the exclusive suppliers of Silvertone television receivers. Tele-Tone was reputed to have financial backing from the Frank Costello Mafia organisation and this - if true - might help explain what happened in September of 1950.

The Sears staff responsible for liaison between Tele-Tone, Air-King and Chicago was multi-layered. In the windy city, a shorter-than-average Arthur Chameroy ruled Division 57 with an iron fist. He was in charge and cut from the same cloth mould as David Sarnoff. Sava describes Chameroy:

"His attire was always fastidious and all 5 foot 1 inch of the man reeked of authority. He was the reigning king of Sears' largest and fastest growing division, who could make strong men weep with a stare or a frown."

In March 1951, CBS's Goldmark displayed a device which he believed would be a less objectionable device than the color wheel - something called a "color drum." Picture a musical drum of some size turned on its side, like a ferris wheel. Now picture the drum outer face covered with a huge array of filters. A motor rotated the drum in front of a 17 inch black and white picture tube producing color. The concept traded a TV set cabinet with an appendage protruding from the left hand side for a TV set with an unusually tall top, to house the drum. It still required a motor to rotate of course. Jacobson recalls this "innovation" prompted a concept that split the TV set into two separate cabinets; one for the normal electronics and power supplies, and then separately a second wooden cabinet interconnected by a cable which housed the 17" tube and the rotating drum Ferris-wheel assembly. By splitting the receiver in two, CBS hoped they could overcome consumer objections to color TV sets which were very wide because of the pregnant side attachment housing the color wheel, and solve a problem which would haunt the project until its dying days; how to shield the picture tube from the sizeable electric motor and the receiver power supply. Here was the problem, as explained by Jacobson.

"A television picture, like film, consists of a series of frames repeating thirty times per second. The electron beam scanning and forming the image is positioned by a specially shaped pulsed magnetic field. Within the receiver there is another relatively small magnetic field produced by the power transformer; as long as the receiver is turned on, the power transformer generates an undesirable set of pulses on its own which occur at 60 cycles per second. Because sixty cycles is exactly twice the frame repetition rate of 30 cycles per

second, it is in synchronization with the picture and its only effect is to slightly bend vertical lines on the picture tube face.

"In the CBS field sequential system, Goldmark was producing 24 frames per second which was totally out of synchronization with the 60 cycle power line frequency. This caused all vertical lines in the picture to wiggle and shimmy. Goldmark's solution was twofold: Place more and more shielding around the power transformer, and, make the physical transformer larger so that by its bulk less of the 60 cycle energy would radiate into the balance of the receiver."

The motor to spin the color wheel was an even greater challenge. Morris Tucci, Air King's chief mechanical engineer, recalls:

"The hum from the power supply which was difficult was exceeded by the magnetic field from the motor plus the saturated reactors used to control the motor speed and phase. With 1951 technology, the only practical answer appeared to be to build something known as a mu-metal shield to fit totally around the picture tube to shut out all of these stray, unwanted, magnetic fields." For Paley, "mu-metal shielding" would save him from what might well have been a serious financial bath.

Jacobson. "I, privately because it was not appropriate for me to do otherwise, railed against the stupidity of the entire approach. What I could and did do was keep hammering away at the need to keep the product consumer affordable. Goldmark would be accompanied into my lab by Stanton and Paley, the better to 'twist my arm' I thought."

What Jacobson and Tucci are telling us is that Goldmark did not deliver to Air-King a mature color television receiver design. At the very moment when CBS was extremely anxious to have color-wheel receivers rolling off an assembly line Air-King was facing a number of significant design completion challenges.

Returning to the involvement of Sears Roebuck which ultimately, Jacobson believes, led to the abandonment of the color wheel program. When the FCC said they wanted to be "reassured" that field sequential sets would appear in the marketplace before they gave final approval to the "franchise" an unusual sequence of events began in Chicago. Sears' relationship with Tele-Tone and Air-King was internally managed by a person with the title of "buyer." We'll call our TV set buyer "M" and then quickly point out his last name was not McCoy. The sequence.

"M" reads of the FCC decision in "the trades" and sees the violent opposition to CBS reported. He does some checking with other manufacturers and discovers it is unlikely that any will in fact produce the field sequential receivers anytime soon. Then he discovers that publicly traded CBS stock is faltering and in his mind he decides this might be a good time to purchase some for himself. Now he has a "vested interest" in CBS succeeding because if field sequential color takes off his CBS stock could explode in value. Nothing drives ambition like a large capital gain.

"M" knows, as the buyer dealing with Tele-Tone and Air-King, that CBS is, by November 1950, "nosing around" and he correctly reads this as an indication Air-King may be headed for CBS ownership. He uses his Sears buyer relationship to have meetings with both Air-King and CBS - a high level at CBS but unfortunately not pinpointed to a specific person.

Jacsobson was not present when a pivotal meeting was held but his immediate superior, Leopold Kay as Air-King vice-president of engineering, apparently was. And Jacobson obtained independent verification of what follows from members of the Sears technical staff in Chicago.

"M" proposed that he could deliver to Air-King (to become CBS Columbia) one or more purchase orders for Sears' branded Silvertone field sequential color receivers. CBS of course jumped at this opportunity to have the nation's largest retailer prominently featuring field

sequential color receivers and a variation of this "story" expands on it to suggest that it was in fact "somebody at CBS" who created the original "script." The sequence of events taking us from CBS being desirous of having CBS-color on display in Sears stores was, according to Jacobson and Kay, amazingly short. First there had to be a willing supplier. There was. Next there had to be someone at Sears who would recommend the project to management; that would be "M." Finally, his supervisor who would "sign off" on the purchase order. He did.

At Sears the sell was easy and happened very fast. Sears management jumped at the opportunity to be "first with color" at a time when dozens of magazine and newspaper articles appeared every month describing the benefits of color over black and white. To the most oft repeated questions ("*When* will it be available?" and "*Where* will it be available?") Sears with the able assistance of the powerful CBS television network now had a one word answer to both: "Soon" and "(exclusively at) Sears."

Whether the mysterious "M" was to be satisfied with his potential gain in CBS stock value, or that he received some additional "benefits" from CBS for the part he played is conjecture. What is known, according to Jacobson and others trailing back into the Sears organisation in Chicago, is what happened next. Paley and Stanton were adapting to their new role as manufacturers and as CBS held all of the patent rights for not only Goldmark's field sequential color system but through their purchase of Air-King/Hytron a sizeable cache of other patents as well, they needed to establish a licensing division to authorise others to use these patents. This was a new area of business activity for CBS and to oversee it a new title of vice-president of Licensing was created. And a new person hired to oversee the activity. By the strangest of coincidences, the Sears TV set "buyer" who delivered to CBS-Columbia the contract for an initial run of 1,000 Silvertone field sequential receivers was that person. We will return to this shortly but will not be able to answer the obvious question: How does a person who liasoned between a TV set manufacturer and Sears prove his qualifications to deal with patent licensing?

The deck was finally clear of obstructions when on May 28, 1951 the US Supreme Court ruled that the FCC, as an agency of specialised expertise, was to be the final word on whether or not CBS or RCA or CTI would be the color "franchisee." David Sarnoff immediately hit the road for a series of speaking engagements with one purpose in mind: To raise the question in legal minds whether a non-elected body of largely appointed bureaucrats should be unanswerable to court review for their actions. The Chicago Federal District Court and the US Supreme Court had ruled, "this is the way it is and will be." Sarnoff wanted a legal community review of this practice, as Eugene Lyons in "David Sarnoff" wrote:

"According to the Supreme Court, an administrative agency - which often determines economic, scientific, and other questions vitally affecting the public interest - now has the power to speak with a finality not only on matters of fact but also on questions of public policy. If federal commissions, boards, and other agencies are to be held to the principle of checks and balances, there ought to be some place to go where a judicial review of the substance not merely the form of a case can be secured."

CBS's initial red headed telecast featuring Arthur Godfrey was away; CBS's publicity department was running "Color NOW!" advertisements almost daily in New York and Washington newspapers. CBS-Columbia had become the new name for Hytron / Air-King and NBC was responding with weekly public demonstrations of its own "compatible color." Sears was on board and Jacobson and group at the Brooklyn plant of Air-King was up to its collective CBS-eyeballs in practical problems. Before there could be a production run of 1,000 receivers, a smaller pilot run of 100 was underway by early June. Jacobson had hired a number of additional engineers to work on the production challenges created when Peter Goldmark dumped a semi-completed prototype field sequential color in their laps and Paley

said, "build them." Israel Melman and Edward White came from the RCA Labs to set up a Research and Development department that would identify and find solutions to each of the Goldmark unsolved production problems.

Although RCA had completed its Washington hearings demonstrations using a single color picture tube, such a tube was not available to CBS-Columbia and even if it were, according to Jacobson, "because of the inherent resolution limitations which field sequential color carried as baggage, the picture would have been quite poor, especially on larger kinescopes."

What Jacobson did not know was CBS + Sears were trying to pin down a "public showing date" for the field sequential receivers which were still only partially completed on the Air-King assembly line. RCA was bringing out ever better dot sequential receivers almost weekly during May, June and through July 1951, largely the result of a new liaison RCA had formed with Hazeltine Labs that brought a number of important not-invented-at-RCA badly needed innovations to the receiver design.

The heat on Jacobson and his small technical crew was intense. He recalls:

"The pressure came from CBS brass (read Goldmark, Stanton and even Paley) as well as from (internal VP) Leopold (Les) Kay. Les was an interesting character, almost completely ignorant in technical matters, he achieved his position during World War Two by an ability to get along with military contract officers, and because of his superb interoffice political skills. CBS's pressure on him - and his in turn on me - was the promise of a bonanza of riches for us all. Far from protecting or defending me and the engineering group, he was an active player in bearing down and brooking no excuses for failure to achieve CBS-drawn schedules. And his method may have been effective. A hundred unit pilot run was in preparation (although none of us were certain how it would turn out) when RCA's new daily 'experimental color schedule' hit CBS between the eyes. Obviously RCA was not going to make it easy for CBS."

"The Sears contract called for the television receivers to be able to receive both CBS color and standard monochrome signals. A turn of a switch on the front of the receiver was to accomplish the changeover. This task had become awesome because of the many non-common components that required switching between the two formats."

Goldmark before the FCC had of course dismissed this "challenge" by repeatedly pointing to an "adapter" which he characterised as "inexpensive and quick to install" in existing receivers. The truth was far removed from Goldmark's witness stand hype.

"Buoyed by Goldmark's staunch stance on this issue, the design problems we were facing were dismissed by the CBS people as 'childish bellyaching by overpaid tekkies' as if properly focused management procedures, properly applied, like a good sales program, would solve all difficulties."

In June 1950, the North Koreans had launched a pre-emptive attack on South Korea. The American response had been slow at first but by June 1951, the country had returned to a war footing which brought in an entirely new set of problems. Jacobson on what this did to his CBS created time table for delivery of the first field sequential receivers.

"Components that had been freely available - vacuum tubes, resistors, capacitors, transformers, hardware - vanished as if sucked up by a giant vacuum cleaner. We at Air-King were fortunate in being a subsidiary of Hytron, the fourth largest manufacturer of vacuum tubes. My telephone became a swap center as we called our friends in other companies trading our surplus for theirs. We quickly adapted to substituting components that were 'almost right' for those that had been originally specified by circuit design, to enable our production lines to continue. The field sequential color sets were but a small part of a much larger operation involving ongoing military contracts that suddenly exploded in size, table model radios and of course black and white TV receivers for the current Sears sales.

"When you have a 'mature' product such as the 7" Sears 'portable' receiver, over time you learn where you can make parts substitutions or even eliminate parts and not have an adverse negative impact on the product's performance. This only comes with volume. But those first 100 field sequential color sets had no forerunners on which to draw for experience so the 'margin' of performance that varied when we were forced to substitute 'almost right' parts was thin. In fact, we would never know whether with exactly correct parts the new color receivers might work or not which is why we were building an initial pilot run of only 100 units."

Some of the component parts were as new as the field sequential color system; the color wheel, for example. A firm specialising in magnetic deflection parts for TV manufacturers, General Industries, began submitting sample color wheel assemblies to Air-King early in 1951. This was at the time that Goldmark was making his last attempt to influence final product design with the ferris wheel rotating filter system that allowed the receiver to be broken into a pair of separate cabinets. Morris L. Tucci, at the time chief mechanical engineer at Air-King / CBS Columbia, recalls:

"Ultimately the color wheels were built in our premises using purchased components. I spent six weeks at the CBS labs learning the various subtleties of color wheel design and assembly. For monochrome viewing, a special centrifugal controlled mechanism moved the color wheel to the side revealing a clear filter. When the color wheel started up the color filter fell back into place."

There were more mundane parts which required new expertise. One example; the TV set's flyback transformer which is a part of the image painting system for the TV screen had an upper frequency limit of 32 kilocycles which was woefully inadequate for the field sequential system. Goldmark had created one-off parts in his lab for demonstration receivers but even a modest production run of 100 units ruled out hand making parts internally at Air-King. The list went on and on and daily Les Kay and brass from CBS appeared to demand, "What's holding up the program???"

Sears. Years after the project, CBS sources deny a close relationship with Sears, perhaps because of the method by which it was broken off. A major piece of evidence to the contrary is a copy of "News Graphic" dated September 20, 1951; a Sears employee publication. A secondary piece of evidence that Sears was up to the CBS eyeball in color planning is found on page 643 of the Spring 1951 Sears catalog. In a prominently displayed "text box" it reads: "A WORD ABOUT COLOR TELEVISION. Sears guarantees that these Silvertone television receivers can be used with an attachment to receive color television programs transmitted in accordance with the standards established by the Federal Communications Commission on October 10, 1950." The same claim appears on page 793 of the Sears Fall 1951 catalog and on page 726 of the Spring 1952 catalog. It did not appear in future editions. Remember, Spring 1951 is *before* even Air-King had produced field sequential receivers. And, Spring 1952 will be six months *after* CBS tosses in the color towel.

Such "assurance" could only have come from Air-King / CBS Columbia and now that we understand the very real "attachment" design problems Sava Jacobson was facing four months after this catalog was released, we can but surmise that even with their own technical resources in Chicago, Sears was being led down a garden path by CBS.

On July 12, 1951 Sears unveiled in public CBS field sequential color television to the public. The News-Graphic report, here in full, leaves no doubt that Sears and CBS-Columbia had a very close relationship.

"Amazement grew in Brooklyn as ... . Audience glued eyes on 1st Silvertone color TV screen. (New York City). On a recent Thursday, Brooklyn, home of the beloved 'Bums' and other famous local heroes, scored again. The store here staged the first public demonstration - anywhere in the country - of the new, self-contained, Silvertone color TV receiver.

"Special - guest invitations had been sent to a selected list of preferred customers, the press, managers and selling personnel of company stores in the New York City area. So a fair crowd was, naturally, expected. But a full half-hour before that morning's CBS color broadcast at 10:30 a.m., whole families began pouring into D/57.

"Grandmothers and grandfathers, mothers and fathers, children of all ages (including babes in arms) and their assorted cousins, sisters and aunts came. It was really like Christmas in midsummer!

"Odell explained it. The demonstration was opened with a revealing talk by Chicago's Douglas L. Odell, D/657 retired sales manager. He described, in laymen's language, the intricacies, present limitations and boundless possibilities of the fabulous new entertainment medium ... color TV.

"The Silvertone color TV, used for the Brooklyn demonstrations, it is reported, was the only one in the world at that time capable of receiving either color or black and white with the mere flick of a switch.

"Self contained, it is equipped with a 10-inch tube, magnified to a 12-1/2 inch size, and all of the mechanism is concealed in a handsome mahogany cabinet with fold-back doors on the upper half.

"An interesting comparison between color and black and white reception of the same broadcast was shown. There was a standard black-and-white TV set - a small console, specially adapted for the purpose - set up next to the Silvertone color TV cabinet.

"Home ec. gal was star. The first Brooklyn demonstration picked up the CBS broadcast of the show 'Modern Homemakers.' Wearing a simple summer dress of watermelon pink, Home Economist Edalene Stohr, gave the cooking lesson in a kitchen resplendent with modern white enamelled equipment against aquamarine walls and cherry red accessories. (Note: What a spot for Harmony House colors!)

"Miss Stohr's opening picture consisted of southern fried chicken sizzling in a gleaming, stainless-steel skillet. While that was cooking, she prepared (on a celadon green platter) a mouth-watering array of ruby-red sliced tomatoes, frilled with freshly-sliced cucumbers, scallions with their pale green stems, and emerald-green pepper rings.

"The vegetable course was a luscious arrangement of garden fresh peas and brilliant orange colored carrots, quartered the long way.

"Comedy relief (unrehearsed). All of the viewers at the demonstration drooled - actually, visibly in some cases! - when Miss Stohr created a marvellous layer cake, piled high with pale-pink, seven-minute, whipped frosting. And then lavishly covered with fresh strawberries!

"As she was carefully arranging the fluffy frosting, a big, coal-black house fly made a perfect six-point landing smack on top of the cake. It's satisfaction was brief. BANG! It was liquidated by a swift smack of the cook's spatula - off the cake!

"Miss Stohr's neat coup brought roars of laughter from the Sears-store audience. Miss Stohr went on ... calmly as if nothing had happened.

"Hungered again. The colorful meal was completed by tall, frosty, glasses of iced coffee, chilled with cubes of frozen chocolate for 'exotic flavor'. And her dish was topped by a huge white cloud of whipped cream.

"Seeing such an irresistible meal in actual colors on the new Silvertone Color TV made everyone in the audience ravenously hungry.

"Typical remark reported: 'Gosh! I just had lunch. But I could eat all THAT right now!' What better proof of how vividly sharp and clear the CBS color program was received on the Silvertone? Also, it indicated what a terrific impact color, added to television, can have on an audience!

"About 350 attended the initial morning broadcast, and well over 400 caught the afternoon show."

A photograph of the event, perhaps strangely showing a line of people waiting for admission, carried the following caption: "GUARDRAILS WERE NEEDED as men, women, and children crowded into D/57 during recent Silvertone color TV demonstrations in the Brooklyn, N.Y. store. Hundreds asked, 'How soon will color sets be on sale?' as they signed preference certificates entitling them to be among the first to get their sets. It all bodes well for the future popularity of color television."

Why Brooklyn? Why not in the home town of Sears - Chicago? Sava Jacobson.

"Sears maintained their own technical laboratory in Chicago and our finished designs were examined there. However, because no TV station in Chicago was equipped to broadcast (CBS) color, they sent various technical personnel to New York to check on the weekly progress with the color receiver that would one day say 'Silvertone' on it."

Sears could not hold a public demonstration in Chicago simply because there was no CBS color transmitter in the city.

So - did CBS and Sears have an agreement? Was the ex-Air-King factory to produce Silvertone field sequential TV sets? On July 12, 1951, a Sears store in Brooklyn, New York equipped with at least one 12 - 1/2 inch color receiver demonstrated CBS on a Silvertone TV set to "preferred customers." Moreover, some quantity "signed preference certificates entitling them to be among the first to get their sets." Additionally, a specially adapted "small console" demonstrated black and white reception of the same CBS color-casts for comparison by the audience.

Jacobson. "Any buying entity, especially one as large as Sears, has obvious leverage over its sources. Sears people who visited were divided into two groups; the technical types who understood my design and production problems and the sales types who like Paley and Stanton only wanted to see completed receivers in Silvertone cartons."

Some very serious events happened shortly after the Brooklyn demonstration, or perhaps just before. They were probably not related to one another but taken in combination appear to have caused a major change in Paley's attitude concerning "his color franchise."

On June 18th, the "Second NTSC" committee was formally established. This would be the group that would refine the RCA "compatible color system" and who, on June 25, 1953 would, with RCA, finally point the FCC towards "all electronic" color. For Paley, following his Supreme Court win only three weeks prior, the handwriting was well and truly "on the wall." He might have "the franchise" but nobody was going to provide him with meat and potatoes to operate it. It was going to be "CBS against the world" and even Paley knew how that would turn out.

RCA under Sarnoff direction had stepped up their public visibility during June and early July. Peter Goldmark wrote:

"General Sarnoff ran the opposition like a military campaign. Ads, rumors, noise, confusion and then attack on two fronts. Gathering strong industrial forces on his side - industry had a big stake in black and white - he lashed out at the members of the commission, declaring they were working against the public interest."

And then there was the matter of which comes first - the color programming (as in, "the chicken") or the color TV receivers (as in, "the egg"). TV set manufacturers had struggled through 1950 and the first half of 1951 facing a constant barrage of "Color NOW!" campaigning from CBS. From the end of 1949 through mid 1951, the number of black and white TV sets had grown remarkably; 2,500,000 to 5,100,000. But virtually every sale had an addendum attached: "Will this work with the new color?" - the same problem Sears

addressed with their catalog statements assuring buyers that "attachments" would be available.

Thus late in June, early in July, Paley had Sears and only Sears in his pocket and something less than 100 sequential color TV sets to his name. And then he lost Sears, apparently very shortly after the July 12 demonstration in Brooklyn and perhaps before.

Sava Jacobson saw it happen this way.

"'M' was unmasked by Sears G-2; his complicity in bringing CBS and his employer together was worked out by Chicago."

The actual sequence of events, give or take 72 hours, is uncertain but as his scheme unravelled either he went to CBS pleading for help and was rewarded with a vice presidency of the licensing division, or, he was in fact fired and then on the rebound positioned by CBS. In either event, "M" escaped to CBS and Sears in the interest of protecting their own corporate integrity burned and buried and dismembered everything in sight that might be linked to the subterfuge. How they missed the 'News-Graphic' report on the July 12th show 'n tell in Brooklyn is unknown but as there was significant consumer press coverage of the story as well, perhaps Sears decided they couldn't hide that singular event and thought it "proved nothing" relating to the corporate espionage alleged to "M."

How many color sets were badged as "Silvertone?" Jacobson believes almost none. And in fact we can confirm only "one" - July 12th in Brooklyn. As Air-King's line struggled to complete the 100 unit pilot run, CBS was busy establishing potential distributors for its "CBS Columbia" nomenclature color receivers. If the "loss" of Sears was a major concern to Paley, it was not in July 1951 enough to have him shut down the Air-King production line. Jacobson counted 52 different brands of TV sets, many of these small but all with distributors. America was going bonkers about TV and this was before the FCC lifted its freeze opening up TV for the first time to in excess of 70% of the land mass. A production line for 1,000 color receivers was begun in July and according to Jacobson and others working at Air-King, "every set coming off the end had a 'CBS Columbia' brand plate."

In a TV set universe growing at a rate of several million per year, CBS Columbia by itself could not make even a small dent in the color penetration. Which presented Paley with his ultimate nightmare. The larger the non-compatible black and white universe, the greater the number of homes who could not tune-in his network whenever he switched to color. The "cash cow" that in the end had to fund all of these fun and games was CBS - *the network.* How long could CBS take even one hour per day out of its commercial schedule to serve a few hundred, a few thousand or even a few tens of thousands of color TV sets to the loss of the much larger multi-million home maketplace? And yet if there as not sufficient CBS color programming to encourage set sales, how could CBS expect color penetration to grow? It was the chicken and the egg scenario. Perhaps, as Peter Goldmark wrote, "Paley was hypnotized with Air-King. So was Stanton. It seemed incredible to me that two of the leading communication figures in America should be spending so much time fiddling with dials and knobs."

Paley the realist finally took over but Paley the showman had to create some way to "get out of this situation" without losing face. He was not accustomed to failure and above all his pride was going to be badly wounded if the CBS color project was shut down from within.

There was a way although authorship for the creativity is not recorded in history. It came down to two elements: The Korean War NPA ban on mass production of products which were "needed" by the war effort and Peter Goldmark's albatross - the unconventional 48 frames per second.

Recall that one of the challenges faced by Sava Jacobson and Morris Tucci was the "stray magnetic fields" generated by the TV set's power transformer plus the mandatory electric

motor that was required to rotate the color disk at 1440 revolutions per minute. Goldmark had tried to talk them into splitting the TV set into two pieces - all of the electronics in one cabinet, the kinescope and rotating color mechanism (whether a wheel or drum) into another. But as Jacobson and Tucci worked out, there was only one solution and it was not a good one with respect to the economics of building the receivers. A special "mu-metal" shield, to stop the magnetic fields from the motor and transformer leaking into the picture tube, was mandatory.

It would be Morris Tucci who one day worked out that with all of the parts in place, the TV set built and in a CBS Columbia shipping carton, the first 1,000 receivers off the line cost the company on average $100 *more* than they were going to receive for them from distributors. Perhaps losing $100 each on the first 1,000 units built was not a "major" for CBS but this added fuel to the fire already building in Paley's head.

mu-metal was the scape goat. Some sources say that amongst his many honorary and occasionally "real" positions in the semi-political world, Paley was on a board that had the final say on what "raw materials" would be "removed from civilian consumption" for the duration of the Korean Conflict. The National Production Authority (NPA) had the ability to, for example, declare "milk a product in short supply" and further dictate, "it would only in the future be available to the military." Of course milk was not in short supply but mu-metal, the NPA decided, was.

On the CBS Columbia Board of Directors was a man named Al Stobbe who also was a VP of CBS-Columbia. His position on the board was something of an enigma, at least to Jacobson, Tucci and others interviewed. It was known that he "represented an outside investor in Air-King" - someone other than CBS + Paley. Beyond that, no hard information although his reputation at Air-King was one that commanded reverence because, it was said, "he had connections."

VP Stobbe was given the task of going to Washington and appearing before the NPA bureaucracy. Jacobson relates, "Stobbe went to Washington because it finally became obvious to all the system was an embarrassment, a disaster waiting to happen, and potentially costly for everyone concerned."

On November 20, 1951, one year to the day after the FCC had designated CBS could begin commercial broadcasting of color, the National Production Authority released "Order M-90" which said in effect, "because of the need for mu-metal in manufacture of war goods for Korea, all manufacturing of color television receivers using this metal must cease."

Nobody was fooled but Paley saved his pride. The much larger production of black and white receivers, consuming several thousand times as much mu-metal per year as the very limited CBS color set production, was not mentioned in the decision.

The reaction at Air-King was immediate. Not only was all further assembly line work on CBS-Columbia color sets suspended and all R & D stopped, but a ceremony followed at which David Cogan, the firm's president, invited key management and engineering personnel to join him in his office.

"Opening his sideboard, he took out whiskey and glasses and proposed a toast that went like this:

'May future generations view the CBS color television system with the same fond reverence now accorded the Stanley Steamer.'

"With that we raised our glasses. *The nightmare was over.*"

CBS Color Epilogue

Peter Goldmark in Maverick Inventor relates a story that others often repeat. Here's the setting. It is late May 1951 and the US Supreme Court is about to announce their decision

after RCA appealed the Chicago Federal Court decision which upheld the FCC's "agency of expertise" decision for CBS color.

In the anxious audience are David Sarnoff and William Paley. Pointedly, Sarnoff has the better more forward seat. He turns around to Paley and utters one line:

"Bill, we could have avoided all of this if I had hired Peter in the first place."

"The nightmare over," CBS-Columbia's Air-King begins a long slide into oblivion to ultimately disappear in 1956. Three pieces of unfinished business deserve mention. If nothing else, Dave Cogan and the CBS marketing team has done a competent job of moving more than 1,000 12-1/2" color wheel sets from the finishing floor at Air-King to dealer showrooms and even some consumer locations. Paley issues a dictum. He knows, now, that CBS will never again telecast in field sequential color and to avoid a series of (class action) lawsuits and the attendant bad consumer publicity, he wants them back. A man named George DeRado was named special assistant to Dave Cogan in December 1951. His job was to locate every single CBS color receiver, and get it back. No matter the cost. When returned to Air-King, they would be disassembled, gutted for parts (which were sold on the surplus market as "used parts," largely to South America) and eventually even the written records would be disposed of. Permanently.

DeRado, "I knew of no receivers at Sears but possibly some of the original 100 built as a pilot run ended up there and escaped my hunt and destroy purview." Out of 1,000, DeRado claims to have found "all but ten or twelve." Three of these have known homes, one in an extensive "collector's museum" in Toronto maintained by the son of City-67 TV station founder Sruki Switzer (the other two are in "private collections" and today have a 'street collector's value' in excess of $25,000 each). TV and radio set collectors, a subgroup of humanity which exists at weekend swap meets from coast-to-coast, live on in the fond hope that someday, somewhere, they will pull into somebody's yard sale in response to an advertisement reading, "strange color wheel TV set for sale" and discover one of these "gems." DeRado's assignment was to make certain this would never happen - he batted close to 99.9%. About the original 100 pilot run.

"Unfortunately, it was 'help yourself time' and we believe 3 or 4 ended up in Chicago at Sears while many others went out the doors to Paley and Stanton for redistribution to friends, advertising execs and others whom CBS hoped would help them in their fight." In fact, some did end up in Chicago and collector David Johnson, there in Berwyn (Illinois), has an unusual ornament in his basement (including, a fully operational CBS color wheel TV camera and production system - perhaps the only "complete" survivor of the CBS color wheel era!).

Item two. CBS-Columbia's relationship with Sears. "M's" posture in all of this remains an enigma wrapped in a hot dog bun. He can be traced to leaving CBS and after but has never spoken (nor agreed to speak about) the period in question. Sava Jacobson, rattled by his deteriorating relationship with chief engineer Leopold Kay, left Air-King immediately after CBS shut down the project, and just weeks before Derado appeared. But he maintained friendships with those who returned to the more mundane business of turning out black and white TV sets and TV-radio-phongraph combinations for prime customer Sears and adds this anecdote to how Sears one day found themselves without CBS-Columbia product.

"Allegedly reacting to complaints from CBS-Columbia dealers, CBS decided to terminate the agreement with Sears in a spectacularly brutal manner (1953). CBS's service representative, in a routine visit to Chicago and Sears, dressed down in a black leather motorcycle crowd jacket and attire and walked into Arthur Chameroy's office to deliver a message directly from Frank Stanton: 'CBS will not honor any further contracts for Sears after the current deliveries'. To understand the magnitude of the insult, picture Arthur, the reigning king of Sears' largest and fastest growing division, being given this message by an

uncouth black leather-jacketed underling!" Air-King's CBS-Columbia operation closed down in 1956.

CBS was, indeed, as William Paley loved to remind people, "in show business." Sears management responded by purchasing two firms (Warwick in suburban Chicago and Pacific Mercury in California which was limited to producing Silvertone for the 11 western states - transportation costs being a major added factor to shipping out of Chicago) which they would then run as corporate entities to produce the radio and TV products they required. They had their fill of "show business" folk.

And item three. NTSC color. It finally gained FCC approval (1953) but it would be 1978 before color TV set production surpassed black and white set production; an additional 25 years.

It began in 1940, it ended in 1952. CBS, according to Newsweek and other studies, "lost $5,000,000 pursuing the golden color ring." Perhaps, but for William Paley and Peter Goldmark, it was the adventure of a lifetime.